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TRUFFLE CULTURE IN FRANCE.*

By JACQUES BOYER.

THE origin of truffles was long enveloped in mystery, but now, after the researches of Tulasne, Chatin, and, in particular, Duke Gramont de Lesparre, the opinions of botanists are definitely fixed. The truffle is a mushroom of the order of thecaspores, that is to say, its spores or seeds are inclosed in soprangia or "thecæ." Of varieties we may mention, first, the violet truffle, which abounds in Périgord and Provence. It is covered with polygonal warts and often marked with rusty spots. Its weight usually ranges from sixty to a hundred grammes (2 to 3½ ounces), though specimens weighing 500 grammes (more than a pound) are sometimes found. At maturity, which it reaches in late autumn or winter, its flesh is black with a reddish or violet sheen. Its agreeable flavor and delicate odor make it the most highly esteemed of all varieties.

The black truffle, smaller than the preceding, and of variable size, is found four inches below the surface of the ground. Its flesh is gray or bister, marked with light red spots at maturity. It is not in very great demand, because of its musky odor.

The St. John's or summer truffle is gathered in July or in October. The tubers of this species are rounded and have a brownish black skin and large polygonal warts, striped transversely. The flesh, nearly white at first, becomes, on ripening, a clay yellow or light brownish bister. The summer truffle is found everywhere in the forests of central and southern France, growing under hornbeams, birches, and hazel bushes. Though its rather coarse, onion-like odor lessens its value, it is almost the only variety seen in the markets of England, Germany, and Piedmont. The truffle known as the "grosse fouine," or "pitchfork," somewhat resembles the St. John's truffle, but is distinguished from it by the smallness of its warts, its moderate size, rough black skin, and dark tawny gray flesh, marked with fine black lines, and usually by a broad cleft near the base.

Another wild species which is still sold is the musk truffle, known in Provence by the name of "caillette."

The remaining wild species, which are included under the general designation of "dog's nose," because of their resemblance to the muzzle of that useful quadruped, possess no gastronomic importance.

In regard to the yield of a truffle ground, the principal factor is the nature of the soil; calcareous soils appear to be the most favorable. When the lime is in a state of very fine division, the tubers develop regularly, while in hard, stony ground they become crooked and distorted. Sunny slopes on which oaks, beeches, and vines grow are admirably adapted to truffle culture.

In the second place, truffle growers welcome torrential rains in July and August. When rain falls in moderate quantity in April and May, and again in September, the crop is usually excellent, while prolonged autumn rains greatly retard the growth of the truffles. Cold has a favorable influence on the ripening of the precious tuber, which does not attain its full flavor until the end of December, or in January or February. If, however, frost goes deep enough to reach the delicate fungi, they die, decay and lose all their

COOKING THE FILLED JARS AND BOXES.

WOMEN CLEANING TRUFFLES, AND PACKING THEM IN JARS AND BOXES.

TRUFFLE CULTURE IN FRANCE.

* From American Homes and Gardens.

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commercial value. Another condition indispensable for the development of truffles is the presence of trees. There are some thirty species which satisfy the condition more or less perfectly. Oaks are the best; then come beeches, hornbeams, chestnuts, hazels, junipers, etc. According to Larbaletrier, the benefit derived from trees is confined to the shade and shelter which they give, so that the species is of secondary importance. Nevertheless, truffles abound especially at the feet of oaks of various species, notably the white and the downy oak.

To return to demonstrated facts, we find that truffles are also subject to limits of altitude. The Périgord truffle, for example, is not found at elevations exceeding 800 meters (2600 feet or half a mile), either because it cannot adapt itself to the climate of great altitudes or because the trees which it needs do not grow there.

Truffles are produced in natural and in artificial truffle grounds. Natural truffle grounds appear spontaneously, and human care is confined to gathering the crop and sparing the sheltering oaks. A very curious fact has been observed in this connection, namely, that truffles are never found around very young trees. Long before the tubers develop, the site of the future truffle ground has revealed itself to experienced eyes. The shrubs, herbs, and grasses have faded, withered, and finally vanished, leaving the place bare and "burned," to use the local term. Then the truffles appear and the surface of the ground remains bare and barren until the truffle bed has been exhausted, after which the place again becomes covered with verdure.

Artificial truffle grounds were unimagined until the beginning of the nineteenth century. Until 1898 they were made by the simple process of sowing acorns broadcast on favorable soil after deep plowing. Another method consisted in planting truffles two or three years old. A little earth taken from an old and bearing truffle ground was sometimes strewn over the new one.

In consequence of the discovery by M. Gramont de Lesparre of the productive principle of the truffle mycelium, a more rational method of propagation has lately been adopted. The spore of the truffle does not germinate either within the fungus or in the ground. It must be carried, by the wind or otherwise, to the leaf of a tree—oak, hazel, beech, or pine, for example—to which it attaches itself by means of its spines, and promptly sprouts if it has found lodgment near the midrib of the leaf. The male spore produces a filament which grows and runs under the epidermis of the leaf until it meets and fertilizes a female spore. Then the latter emits sporules, which, falling to the ground, develop into the truffle mycelium, or "spawn."

On the basis of these discoveries truffle growers now proceed as follows: During the winter they select very ripe and round Périgord truffles, untouched by frost, and dry them rapidly in the open air. The dry, hard tubers are subsequently softened by soaking in water, chopped and crushed between two pieces of ground glass, one of which is caused to glide over the other in such manner as to reduce the truffle pulp to a stiff paste, which is thinned by the addition of a little water. The object of this process is to break the little sacks, or "thecæ," which contain the spores, for the latter cannot develop until they have been released from their envelopes. Then, to start the germination, it is only necessary to apply the thin paste with a soft brush to the midrib of a green leaf in the shade and to keep it undisturbed for from six to twelve weeks, according as the operation has been performed in May or in autumn. After the expiration of this period the treated leaves are gathered and buried in the ground prepared for their reception.

In fact, science has confirmed, by explanation, the essential truth of the popular belief. Though the tree is not actually the parent of the truffle, its presence is indispensable to the truffle's propagation, so that the popular saying, "If you want truffles, plant oaks," remains correct in substance. The common sense of our fathers foresaw what only the microscope can see in detail.

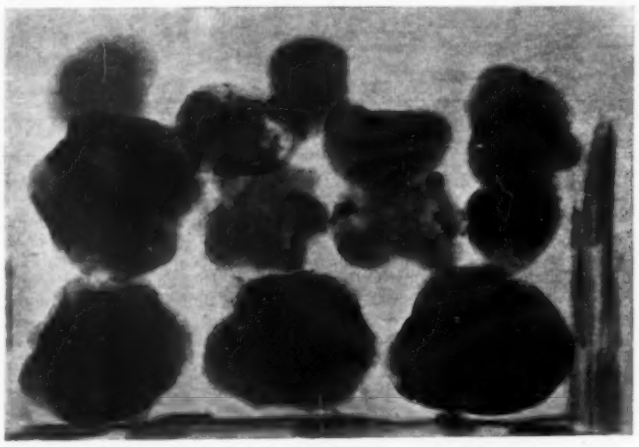
Now, how shall we go about to discover the whereabouts of truffles buried six or eight inches underground?

Some shrewd peasants possess an extraordinarily keen scent for this sort of game. There are other indications, such as cracks in the soil, absence of vegetation, and in fine weather swarms of golden-hued flies hovering over the truffle ground. But sunshine and flies are rare in the winter months, when the truffles attain maturity, and few are the fortunate individuals who can find the tubers unaided.

So recourse is had to animals whose sense of smell is better developed than ours. In Dauphiny, Burgundy, and Champagne, as well as in some parts of Provence and Quercy, the dog is pressed into service. This animal is especially well adapted to regions where the truffle grounds are scattered, because of his quickness of motion and his ability to travel great distances.

The life of the "rabasseur," "caveur" or truffle hunter is not altogether a happy one. His most abundant harvest is in winter, when north winds are keen and competition is so intense that he is forced to begin work very early in the morning. The following account of a day in the life of a truffle hunter is based on an interview obtained by the writer at Martignac.

He rises before daybreak and packs a bag or basket with food, a gourd of wine and a checked handkerchief to hold the truffles. He also takes a staff and a pick, the latter for the purpose of carrying on the search to the spot indicated by his intelligent four-footed comrade. Often he reaches the hunting ground and the hunt commences at sunrise. The dog sniffs the ground and stops over a truffle, which the man promptly digs up with his pick. If the place seems likely he then kneels and searches the subsoil round about for other tubers, pausing now and then to encourage his dog with a bit of bread. So he works on through the day, except for a short recess for lunch, and after tramping many weary miles returns to his hut by twilight with a few pounds of truffles.



RADIOGRAPH OF TRUFFLES LOADED WITH LEAD, IRON, CLAY, ETC., TO INCREASE THE WEIGHT.

A nail shows clearly in the middle truffle of the bottom row.

The yield varies not only with soil and locality, but also according to the season. Drought sometimes reduces the crop to half its normal amount.

On the day after the truffles are gathered, the local porter or carter conveys them to the chief village of the canton. Here they are usually delivered to the "leveur," who collects the product of several neighboring communes and takes it to the nearest market town, whither wholesale dealers come to purchase it.

According to M. Mouillefert, the truffle hunter's dog is usually either a water spaniel or a small, smooth-coated pug, but almost any breed may be used. The dogs are trained for their work by mixing truffle parings with their usual food and burying this in the ground, or by burying small truffles with pieces of bacon, which the animals are taught to unearth. After each find the pupil is rewarded with a morsel of bread. A well trained dog is worth from forty to a hundred dollars.

But in districts where truffles abound, and in artificial truffle plantations which are regularly cropped, hogs are employed in the search for this delicacy dear to the epicures of two hemispheres. Sows are preferred, because they furnish pigs in addition to truffles, and also because, when deprived of food, they perform their duties better than boars would under the same conditions.

The sow scents the truffle from afar, goes straight to it, digs it up with her snout and would promptly devour it if it were not adroitly snatched away and replaced by a handful of acorns, chestnuts, or maize. She is trained much as a dog is, by arousing her olfactory sensibility, and at the age of three or four years becomes an expert truffle hunter, finding from six to twelve pounds a day, and even more in some artificial plantations. But though a healthy sow is able to hunt every day she is allowed a day off now and then, as daily hunting from the end of November until March would exhaust the poor creature.

After the truffles are gathered they are brushed, to remove adhering earth, and the damages are repaired which have been made by mice and other small animals that appreciate the underground mushroom as well as man does. The truffle is also attacked by certain small beetles, and two species of flies deposit their eggs in its flesh, which serve the young larvæ for food. All holes are carefully filled with a suitable paste, and excrescences due to the pressure of stones and other obstacles to growth are pared away.

Sometimes the deception is carried further. Inferior sorts are mixed with genuine Périgord truffles, and nails, clay, and lead are inserted to increase the weight, as the accompanying radiograph shows. Artificial truffles are even made of potatoes, skillfully carved, stained with sulphate of iron and scented by prolonged contact with real truffles!

Now, as in antiquity, the god of thieves is also the god of merchants—some merchants.

Let us leave these adulterations and return to our truffles. The principal French markets are Cahors, Martel, Gourdon (Lot), Périgueux, Excidenil, Sarlat (Dordogne), Carpentras, Apt (Vaucluse), Montagnac, Manosque (Basses Alpes), Brive (Corrèze) and a few others of minor importance.

For the four departments which produce the largest crops of truffles the figures for 1899 are: Lot, 152 tons; Vaucluse, 150 tons; Drome, 135 tons; Dordogne, 90 tons.

The price fluctuates from 7 to 25 francs a kilogramme (65 cents to $2.25 a pound), sometimes reaching 30 francs a kilogramme ($2.75 a pound) in very dry seasons.

But let us leave the statistical and turn to the picturesque aspect of the truffle market, imagining our-

THE "AUTOCLAVES," OR STERILIZERS.

TRUFFLE CULTURE IN FRANCE.

selves transported to Martel on a Wednesday or Saturday in December.

The truffles are not displayed in the market place, but are hidden as if they were contraband goods. The "leveur" deposits his carefully packed baskets in rooms put gratuitously at his disposal by the proprietor of a hotel or café, and then sallies forth to meet the buyers, who are distinguished by their more careful attire and by their purses attached to shoulder belts.

Telegrams announcing the condition of the market

"CAVEUR," WITH SOW, HUNTING FOR TRUFFLES.

at other places begin to arrive at 2 o'clock, but at Martel there is little activity till after 4 o'clock. Then the cafés light up and the baskets of truffles are unpacked on billiard tables and other tables incumbered with beer and absinthe glasses. The buyers examine the truffles, test their weight and converse in low tones with the sellers. But the pitch of voices soon arises, shouts are heard, and, amid wild excitement, the truffles are bought and sold in lots or by the kilogramme. Then comes a period of calm as the final weighings are made.

The truffles are delivered in rectangular willow "champagne" baskets of various sizes, lined with straw paper to prevent contact of the truffles with the basket, which would impair their flavor. These baskets, packed, corded and sealed under the supervision of the buyers, are then sent to the station, to be picked up by the 8 o'clock train and forwarded to Cahors, Paris, Carpentras, Sarlat, Périgueux or Souillac. Meanwhile payments are made and buyers and sellers sit at tables and refresh themselves. At 11 o'clock the little town has resumed its usual calm and tranquil aspect.

Arrived at their destination, the baskets are emptied on long tables and sorted into three grades, according to size. Sometimes, however, the classification is not altogether by size, as the value of a truffle depends to a great extent on its uniform roundness and its texture and ripeness. In addition to the truffles which are consumed in the fresh state a great many go to the canneries and *paté de foies gras* factories. The following description applies to the La Forest establishment at Périgueux, where the various photographs were taken.

One of these shows a number of women washing and cleaning truffles. Before each woman stands a tub in which truffles are soaking in water. The tubers are taken out one by one, carefully washed to remove every particle of earthy matter, and passed to the women on the opposite side of the long table, who remove part of the skin. The parings are not thrown away, but are utilized in various ways. Then the washed and peeled truffles are carried by boys to the left-hand table, where other women pack them in bottles and tin boxes. The boxes, bottles, and jars, whether filled with truffles, *foie gras* or alternate layers of the two, are next cooked in an oven and hermetically sealed, by soldering or otherwise. Then they go to the "autoclaves," or sterilizers, of which three are shown in one of the illustrations. From the first the sterilized jars, contained in a perforated cylinder, are being removed with the aid of a traveling crane. A woman is filling the cylinder of the second with filled and sealed jars, while in the third "autoclave," in the background, the sterilizing process is going on under the foreman's supervision. The time of starting each apparatus is marked on a blackboard.

The sterilizing process is as delicate as it is important. The pressure (which controls the temperature) of each apparatus is indicated by a manometer and must be kept constant throughout the operation. After being sterilized the jars and boxes of truffles go to another room to be washed, labeled and packed for shipment.

This is not the place for an account of the culinary uses of the truffle. Whether served alone "à la Périgueux," or "à la Provencale," or employed to flavor chickens and turkeys, it is a delicacy highly appreciated by the gourmets of the whole world.

SOME NEWLY DISCOVERED PROPERTIES OF CRYSTALS.

IN a paper presented to the Académie des Sciences, M. Fred. Wallerant brings out some peculiar properties of certain crystals, and shows how they add to our knowledge of crystalline structure in general. Crystals of nitrate of ammonium are malleable; that is, they may be bent or twisted without breaking, but in general they lose their homogeneity and become aggregates of crystals. If, however, we compress a plate of this salt which gives the green of the second order in polarized light, the plate becomes thinner and gives successively the blue, the violet, the red, etc., without losing its homogeneity, and its optical direction is not modified. Thus the salt acts like the soft crystals and the crystallized liquids whose existence cannot be doubted since the work of Lehmann and Schenk. M. Lehmann showed that by melting we can transform a solid crystal of p = azoxyanizol into a liquid crystal which is oriented in the same way and only differs from it by a lower bi-refringence. Two important conclusions are to be drawn from these facts. First, the element forming the crystal, the complex particle, remains intact during the deformation. Second, if the particles of soft or liquid crystals have a reticular distribution at a given moment, it is evident that this distribution does not subsist during the deformation, and so we are obliged to admit that the reticular distribution is not an essential characteristic of crystallized bodies. Besides it is easy to accord this result with our idea of crystallized bodies. The latter is characterized by the fact that it is homogeneous—that is, it shows the same properties in all its points according to all the parallel straight lines; and again it is not isotropic—that is, it does not present the same properties in lines which are not parallel. The first mineralogists considered the existence of plane faces as characteristic of a crystal, but it is evident that we cannot keep such a definition, which will not distinguish a rounded grain of natural quartz from a grain of melted quartz. On the other hand it is said that tempered glass or cellulose is not isotropic, but we must not forget that that property is the result of exterior action. Thus our definition is the only one admissible, and it leads to the conclusion that the crystallized body is formed of groups of identical molecules, complex particles, which are directed parallel and distributed like the meshes of a network. This structure has the great advantage of explaining the existence of plane faces, their laws, and the order of the axes of symmetry. But this structure does not satisfy the conditions of homogeneity, since according to two neighboring parallel lines the matter is not in general equally distributed. If practically the crystallized body shows itself to be homogeneous, it is because we do not measure the properties by a straight line, but the mean of the properties by straight lines comprised in a cylindrical portion. But in that case the reticular distribution is not shown as necessary to explain the homogeneity such as we find it to be by experiment. It suffices that the particles placed parallel are close enough together so that the cylindrical portions or threads show the same mean of properties. Naturally in such a body we must not seek for the formation of plane surfaces, seeing that there is no discontinuity between two neighboring planes. We are thus led to consider the phenomenon of crystallization in the following way. The particles exert upon each other two kinds of actions, the first of orientation and the second of attraction. When the latter are strong, the position of the particles is determined. They are arranged according to a network and the crystallized body is solid. If the action is weak, the position is no longer determined for the particles, and they are placed parallel to each other, the body forming a liquid. In the intermediate cases, if the crystallizing conditions are favorable, the particles may be arranged in network form and the crystals, while remaining malleable, are limited by plane faces. But if these conditions are less favorable, the particles are arranged but imperfectly in meshes and the crystals no more present plane surfaces. This is the case with nitrate of ammonia, which, as we know, only shows crystalline forms in very exceptional cases.

The consideration of soft or liquid crystals thus leads us to extend our ideas of the crystalline state. Besides, these crystals show that the properties which vary in a continuous manner, such as optical properties, depend upon the particle itself, and only the properties needing a discontinuity, such as the existence of plane faces and cleavages, are related to the network form.

THE UNDULATORY THEORY.

FRESNEL suggested the first adequate optical theory in 1821, which, though singularly correct in its bearing on reflection and refraction in the widest sense, was merely tentative in construction. Cauchy (1829) proposed a specifically elastic theory for the motion of relatively long waves of light in continuous media, based on a reasonable hypothesis of molecular force, and deduced therefrom Fresnel's reflection and refraction equations. Green (1838), ignoring molecular forces and proceeding in accordance with his own method in elastics, published a different theory, which did not, however, lead to Fresnel's equations. Kelvin (1888) found the conditions implied in Cauchy's theory compatible with stability if the ether were considered as bound by a rigid medium. The ether implied throughout is to have the same elasticity everywhere, but to vary in density from medium to medium, and vibration to be normal to the plane of polarization.

Neumann (1835), whose work has been reconstructed by Kirchhoff (1876), and MacCullagh (1837), with the counter-hypothesis of an ether of fixed density but varying in elasticity from medium to medium, also deduced Fresnel's equations, obtaining at the same time better surface conditions in the case of æolotropic media. The vibrations are in the plane of polarization.

All the elastic theories essentially predict a longitudinal light wave. It was not until Kelvin in 1889-1890 proposed his remarkable gyrostatic theory of light, in which force and displacement become torque and twist, that these objections to the elastic theory were wholly removed. MacCullagh, without recognizing their bearing, seems actually to have anticipated Kelvin's equation.

With the purpose of accounting for dispersion, Cauchy in 1835 gave greater breadth to his theory by postulating a sphere of action of ether particles commensurate with wave-length, and in this direction he was followed by F. Neumann (1841), Briot (1864), Rayleigh (1871) and others, treating an ether variously loaded with material particles. Among theories beginning with the phenomena observed, that of Boussinesq (1867, *et seq.*) has received the most extensive development.

The difficult surface conditions met with when light passes from one medium to another, including such subjects as ellipticity, total reflection, etc., have been critically discussed, among others, by Neumann (1835) and Rayleigh (1888); but the discrimination between the Fresnel and the Neumann vector was not accomplished without misgiving before the advent of the work of Hertz.

It appears, therefore, that the elastic theories of light, if Kelvin's gyrostatic adynamic ether be admitted, have not been wholly routed. Nevertheless, the great electromagnetic theory of light propounded by Maxwell (1864, "Treatise," 1873) has been singularly apt not only in explaining all the phenomena reached by the older theories and in predicting entirely novel results, but in harmoniously uniting as parts of a unique doctrine, both the electric or photographic light vector of Fresnel and Cauchy and the magnetic vector of Neumann and MacCullagh. Its predictions have, moreover, been astonishingly verified by the work of Hertz (1890), and it is to-day acquiring added power in the convection theories of Lorentz (1895) and others.

A "RABASSEUR," WITH HIS DOG, HUNTING FOR TRUFFLES.

TRUFFLE CULTURE IN FRANCE.

THE MANUFACTURE OF ROSIN OILS.*

From the French of E. RABATÉ, Engineer.

IN 1828 Etienne Dive, pharmacist at Mont-de-Marsan, obtained a patent for the conversion of colophony into an oil, which he called "pyrogenous." Hippolyte Dive, his son, perfected the manufacture by distilling the colophony with lime and fractionating the products, preparing limpid and transparent oils. The same processes are in use to-day in the factories of the Landes. There are six of these establishments—those of Forbos, of Lescouzères, and of Lostalot, at Mont-de-Marsan; that of Pouzac, at Dax; that of Castaignède at Pissos; and that of Mesplède at Lesperon. The annual production is estimated at 10,000,000 kilogrammes, corresponding to 2,500,000 francs, at an average price of 25 francs per 100 kilogrammes.

Theory of the Colophony Distillation.—The theory of the action of lime in the distillation of colophony has not yet been satisfactorily established; still, there is reason to believe that under the action of heat, the lime combines with the resinic acids, producing a soap, the base acting preferably on the acids which yield the least volatile salts.

Under these conditions, the distillation of the more fluid and more volatile hydrocarbides is accomplished at first, and the selection of the products coming from the condenser is facilitated.

On stimulating the heat toward the close of the operation, the resinous soaps of the lime base undergo in their turn pyrogenous decomposition, and furnish colored oils, blue and green. The addition of lime increases the fluidity of oils; but the more lime is added the more soap is formed, and the more colored oils are obtained. Beyond a certain percentage of lime, the greater fluidity of the oil does not compensate for the inconvenience resulting from the increase of the impure oils at the close of the distillation. If the lime to be added is estimated according to the quantity necessary for forming with the colophony a neutral compound, the proportion is too high. The best and most convenient proportions are comprised between one per cent and two per cent of the weight of the colophony. Oils with or without lime may be submitted indifferently to rectification; but the derivatives of the first always have the advantage of being more fluid. Toward the end of the distillation the mass to be heated diminishes, and the temperature reaches 500 deg. C. The organic compounds of lime base are then reduced for the greater part into calcium carbonate, which retains a part of the oxygen contained in the colophony.

Slow distillation has the following marked advantages over rapid distillation: 1, the course of the operation is easier to regulate, and the separation of the products is more conveniently accomplished; 2, fire-bursts are less frequent; 3, the mechanical drawing off of the colophony is diminished, and consequently the oils are less acid and less viscid; 4, the empyreumatic odor of the products is less marked; 5, a rapid distillation increases, at the expense of the light oils of the middle distillation, the production of extreme products, water and strong essential oil on one hand and colored oils on the other. On this subject M. Curie has thus expressed his views: "It is of great importance to the manufacturer to study the form given to his apparatus and the manner of applying the heat. By judicious regulation of the temperature, and the rapid or slow condensation of the vapors, the relative proportions of the light liquids and the heavy products in the distillation of colophony may be modified at will. A moderate distillation, with rapid condensation of the products, furnishes colophony abundantly. An elevated heat applied for a long time to a deep boiler, in which the vapors fall back several times before reaching the condenser, diminishes the proportion of colophony, but materially increases that of the extreme products in the series."

Distilling Apparatus.—The colophony to be distilled is placed in cast-iron boilers or kettles, having a capacity of 20 hectoliters, capable of receiving 2,000 kilogrammes. These kettles are usually semi-spherical. One factory in the Landes has, however, experimented with a long, deep receiver, in order to diminish the space occupied by the kettle. The object to be attained consists in securing a practical form, presenting the maximum surface to the heat.

We will consider a kettle formed of semi-sphere and of a cylinder of the same radius, x; the height of the cylinder being y. The heating surface is then $S = 2\pi x^2 + 2\pi xy = 2\pi x\,(x + y)$.

The total height of the kettle is evidently limited on one hand by the fire chamber, and on the other hand by the upper level of the mass of masonry; therefore $y + x = H$; whence $S = 2\pi Hx$.

The heating surface varies with x and becomes maximum at the same time as x. This quantity reaches its greatest value for $y = 0$; whence, $x = H$. The semi-spherical kettle furnishes, therefore, in the present case, the maximum of heating surface. The cap which leads the vapors to the condenser takes the name of retort; ordinarily, the kettles are grouped by twos for each retort and the same condenser. One of the kettles is cleaned and filled with colophony, while the other is under distillation.

Retorts of sheet iron are corroded in a few days, and numerous leaks occur. The pyrogenous acids also form salts of iron, drawn off by the oils, which become heavy, and are affected by the iron. Retorts of copper are now solely employed.

If inconvenience results from causing the rapid exit of the vapors, by too intense heating, it is, on the contrary, quite useful to facilitate their departure, by giving a convenient form to the retort, which is preferably wide and flat.

Condensers of copper are also preferable to those of iron; however, the latter metal is at times made use of in rectification, the oils to be condensed being then but slighty acid.

Often, toward the close of the pyrogenous distillation, the water for chilling is in full ebullition. The exit of the vapors is relaxed, and much uncondensed gas passes. The inconvenience of this temperature (100 deg. C.) is of little account for the production in the last stages of the distillation, the products being of high boiling point and easy to condense. The case is not the same when the heating is produced in the first part of the distillation. A thermometer should always be placed in the condensing apparatus.

Management of a Distillation.—The retort is placed over the kettle, which is filled with 2,000 kilogrammes of colophony and about 20 kilogrammes of lime. The joint which connects the retort with the kettle is luted with clay. The kettle is heated with wood; however, M. Farbos of Mont-de-Marsan makes use of the gas of pine wood. The fire is lighted at 3 o'clock in the morning, and is kept at a moderate point at the outset of the fusion, which is accomplished in three hours. The flame is quickened when all the colophony is melted; the fire is reduced when the distillation commences. There pass successively: 1, incondensable gases alone; 2, acid waters containing, in particular, acetic acid, but in too slight quantity for the advantageous conversion into acetate; 3, the strong, resin essential oil, a reddish mobile liquid of strong empyreumatic odor; 4, brown oils; 5, light-colored oils; 6, blue oils; 7, green oils.

Water, gases, and volatile acids are especially abundant at the outset of the distillation, but these products continue to pass during the whole course of the operation, and contaminate the oils. They are collected in a cast-iron tank, having a lower orifice for the exit of the water, and an upper orifice for the evacuation of the oil. The liquids pass over from 6 o'clock in the morning to 6 o'clock in the evening.

On distilling the colophony rapidly, in four or five hours, without the addition of lime, a thick viscid liquid is obtained on coming from the condenser, designated as strong oil. The employments of this product are not very numerous; it is used especially in mixture with other rosin oils for the preparation of axle grease. One of these fats is obtained by mingling one part of pulverized and sifted spent lime with two parts of the light-colored oil; four or five parts of strong oil are added, and the whole colored with a little blue or green oil.

Products of Distillation.—From 100 kilogrammes of colophony are obtained on the average, at the Lescouzères works:

	Kilogrammes.
Acid water	5
Resin essential oil	3 to 5
Light-colored oils	60
Blue and green oils	20
Carbonaceous residue and volatile gases	10
	100

The compounds intervening in the production of pyrogenous oil are numerous; some are solid, as colophony, lime, calcium carbonate, and the carbonaceous residue; others are liquid—water, acetic acid, and various acids, aldehydes, and hydrocarbides, such as heptene, octene, and turpentine, which form the greater part of the strong resin essential oil; diterebenthyle, diterebenthylene, and didecene, which constitute the greater part of the resin oils. Finally, gaseous products issue from the condenser—carbonic acid gas, methane, ethylene, and butylene.

The average price of the crude oil of the first distillation is 18 or 19 frances per 100 kilogrammes. The account of one operation may be set down as follows:

Receipts.	Francs.	
5 kilogrammes essential oil at 0.25 franc	1.25	
80 kilogrammes oils at 0.19 franc	15.20	
		16.45
Expenses.		
100 kilogrammes clear colophony	10.00	
Packing, hogshead, 3 francs per 300 kilogrammes	1.00	
Transportation of the colophony	0.50	
Combustible	1.00	
Hand work	0.50	
Packing of oil in cask per 80 kilogrammes	2.50	
		15.50
Difference per 100 kilogrammes of distilled colophony		0.95

Recovery of the Combustible Gases.—The gases which come from the condenser in the course of the pyrogenous distillation form a very combustible mixture. In France attempts have been made for some time to branch the condenser at half its height with a siphon tube, conducting the gases into the fire chamber. In Germany, where there are fifty factories distilling American colophony, the gases are used methodically for heating the receivers. The distillation of 2,000 kilogrammes of colophony, according to M. Vezès, requires 1,000 kilogrammes of coal; and 500 kilogrammes of this combustible are sufficient when the distillation gases are utilized at the same time; that is, a saving of fifty per cent in the heating. In some of the German factories two gasometers are installed. The first receives the gases which pass over before the blue oils; these gases are employed for heating. The second gasometer stores the gases disengaged at the tail of the operation; they furnish a clearer and better light than that of coal gas, and are utilized for lighting the factory.

Properties of Rosin Oils.—These are not saponifiable; however, the products of the first distillation contain colophony, which renders them acid and produces with alkalies a resinous soap, communicating to the oil a milky appearance. These oils are essentially formed of hydrocarbides, and cannot be compared with the fatty oils.

According to M. Renard, rectified rosin oil is composed of the following products: Diterebenthyle, 80 per cent, boiling point 333 to 336 deg. C.; density, 0.9688, uncolored; diterebenthylene, 10 per cent, boiling point 345 to 350 deg. C., density 0.982, thick and fluorescent; didecene, 10 per cent, boiling point about 335 deg., density 0.936, uncolored and not fluorescent.

The oils of the middle of the pyrogenous distillation have various defects, which diminish their merchantable value—turbidity, a dark color, acidity, empyreumatic odor, fluorescent reflection, and viscosity. To remedy these faults, or to attenuate them, is the purpose proposed in the refining of the oils of the first distillation.

The density of rosin oils is comparatively high. It has been studied by M. Renard with the following results: Blond oil of the first distillation, average density at 15 deg. C., 0.9823, coefficient of dilatation 0.000663; oil rectified by second distillation, density 0.9712, dilatation 0.000673; blue oil, density 0.9810, dilatation 0.000717; green oil, density 0.9901, dilatation 0.000660; oil of turpentine, density 0.8690, dilatation 0.000918.

Rosin oils are insoluble in water and in ethylic alcohol. On boiling with a large excess of alcohol of 95 per cent, rosin oil is slightly soluble; but cold, it is deposited. On the contrary, rosin oil dissolves readily in amylic alcohol, acetone, benzine, chloroform, oil of turpentine, petroleum, linseed oil, and carbon sulphide.

The air oxidizes rosin oils, increases their density and their viscosity, but has no influence on the acidity, which remains after months of exposure. Sulphuric acid colors them a dark brown, and the surface presents a violet fluorescence.

Rosin oils yield, when hot, nitrous vapors with nitric acid. Their optical activity varies from +30 deg. to —8 deg. 54 min. Fuming bichloride of tin colors them blood red; eladine colors them dark red.

Clarification of Rosin Oils.—The turbidity of the oils is due to the presence of a small quantity of water formed during the pyrogenous decomposition and the calcic saponification of the colophony. This water passes over in distillation at the same time as the hydrocarbile vapors, and the oil retains it in fine globules, forming an emulsion. The clarification of the oils will, therefore, be obtained by eliminating the water mechanically interposed. Different processes are employed. Moderate heating at 70 to 80 deg. prolonged for several hours is sufficient for the elimination of the globules of water. If, during this heating, air is injected, the exit of the watery vapor is facilitated, and at the same time that of the more volatile products, which are the more odorous. The bubbling of the air also contributes to the clarification and to the deodorization of the oil. The operation is accomplished in an open tank of ten hectoliters in capacity, having a steam worm attached, and a tube for injection of air. It may be remarked that this heating increases the coloration of the oil, and completely removes the odor. If the operation is conducted at 110 to 120 deg. the viscosity of the oil is much increased.

M. Douru proposed, some twenty years ago, to leave the oils to be clarified in large reservoirs exposed to the sun and placed under glass roofs. This process has not come into general use. The clarification of oils by the addition of clay has been attempted. This is pulverized, screened, dried at 300 deg., and sifted hot on the surface of the oil. The clay descends slowly, and absorbs the water; at the same time, a material decoloration is produced. One or two per cent of clay is sufficient to accomplish satisfactory results. The oily deposit is sent into tanks for deposit, or passed through a filter press. Other dehydrating substances have been used for clarification, such as sodium, fused calcium chloride, but they are too costly.

Removal of the Fluorescence.—Rosin oils exhibit a blue or green fluorescence, which distinguishes them from fixed vegetable oils. This fluorescence may be readily observed by turning the back to the light when examining the sample. In making mixtures of fixed oils and pyrogenous oils, it is well to free them from the reflection. Manufacturers accomplish this result by the employment of nitro-naphthaline, a yellow powder, of the formula $C_{10}H_7NO_2$. Pulverized nitro-naphthaline is dissolved in a small quantity of oil, and added in the proportion of 0.500 kilogramme to 2 kilogrammes per 100 kilogrammes according to the fluorescence. The nitro-naphthaline renders the oils, which are originally neutral, slightly acid. I have ascertained that mirbane essential oil has also the property of causing the reflection of pyrogencus oil to disappear, but the quantity to be added does not render the process economical. The diterebenthyle

* Communication to the Société d'Encouragement pour l'Industrie Nationale.

and didecene, non-fluorescent carbides, boil at 330 to 335 deg., while the diterebenthylene, fluorescent, boils at 345 to 350 deg. On watching the course of the temperature during the rectification closely it is, therefore, possible to select out the oils that are slightly fluorescent.

Deodorization.—Rosin oils have a very marked and characteristic empyreumatic odor; this property is still more distinct in the resin essential oils. Moderate heating is not sufficient for complete deodorization. A rectification is necessary by washing with soda, which allows of the fractionating of the odorous products. Oils, completely decolored or very pale and nearly neutral, are secured.

The rectification is accomplished in receivers containing 1,600 to 5,000 kilogrammes of oil. Above the kettle and over the cap a metallic basket is hung containing the soda, which falls gradually into the oil, as it is dissolved by the vapors which reach the condenser. It is necessary to apply heat very slowly, so as to allow thirty-six hours for the rectification. When the oil is hot, a current of steam may be sent in with care, but it is a delicate operation. If the water is not vaporized, and accumulates at the bottom of the kettle, outbursts may be caused, and even explosions. A pyrometer is, consequently, an indispensable organ.

The addition of nitro-naphthaline to oils already deodorized by rectification communicates to the product a slight odor, which attentuates the remains of the empyreumatic odor. Mirbane essential oil may also be used for masking the odor, which is replaced by the odor of bitter almonds. Amylic alcohol, added in small portions, varying from 0.2 to 1 per cent, also completely neutralizes the odors of rosin oils. With a slight excess of alcohol, the odor of English sweetmeats is produced. Light-colored amylic alcohol is suitable for this purpose; it is gradually acidified by the air, but it may be preserved over soda, and thus a sodic amylic alcohol be obtained, which allows of removing both the odor and the least trace of acidity.

The deodorization may also be attempted by combining the valeric and butyric acids contained in the oils with ethylic alcohol in presence of sulphuric acid, but the acid blackens the oil, and the small quantity of acid entering into combination causes only a very slight fruit odor.

Neutralization of the Oils.—Rosin oils contain acids, which may be divided into two groups. In the first are arranged the volatile acids, such as acetic, valeric, and butylic acids, which may be eliminated by heating in open air, or by simple rectification. In the second group are to be included the colophony, mechanically drawn off, producing resinic acids, of which pimaric acid is the type.

For fixing these resinic acids, it is necessary to saponify them, and this may be accomplished by employing a rectification receiver and washing with soda. The Solvay carbonate of soda may replace the ordinary soda, but this is more costly; it necessitates expensive packing in sheet-iron cylinders instead of sacks. It is difficult and dangerous to handle, and for neutralization, its chemical power is not superior to that of ordinary carbonate. Theoretically, 53 parts of the dry carbonate, or 40 parts of pure soda, are sufficient for forming a rosin soap with 302 parts of pimaric acid. Practically, 60 kilogrammes of the commercial basic product can be counted on per 300 kilogrammes of the acid.

The knowledge of the acidity of the oil to be treated allows, therefore, of determining the quantity of soda to be employed. At the Fourth Congress of Applied Chemistry, held at Paris in 1900, I made known a new process for the determination of the acidity of rosin oils by means of a solution of caustic soda in amylic alcohol. I have found that this body is a remarkable solvent for various products met with in the determination of the acidity, phenolphthalein, rosin oil, soda, and resinous soap.

Preparation of Selected Oils.—For selecting oils of fine quality, it is important to choose constantly the best products from the commencement to the close of the operation. First, the semi-clear colophonies are to be preferred to the black colophonies; the difference of 0.75 franc per 100 kilogrammes is readily recovered in the oils manufactured; very little lime is made use of, and they are distilled slowly. The blond oils, well fractionated, are rectified immediately with soda, and the middle portion of those rectified is freed from all traces of odor, whether in a tank or a deodorization cylinder. The fluorescence is removed by means of nitro-naphthaline, and all traces of odor and acidity by means of sodic amylic alcohol.

These selected oils rapidly recover some color and fluorescence; so, ordinarily, two weeks are necessary for delivery, which allows for forwarding products of recent production.

On the average, 8 parts of the middle distillation oils at 90 francs per 100 kilogrammes, furnish 5 parts of fine oil at 30 francs, and 2 parts of ordinary oil at 20 francs. The refining applies only to a part of the middle distillation oils, there being numerous outlets for them as they come from the pyrogenous receiver.

These oils are employed for the lubricating of cars in mines, either alone or in mixture with mineral oils. They are often incorporated with linseed oil designed for painting, but the paints which contain rosin oils do not adhere well and tend to split in all directions. Pyrogenous oils may also be used in the production of oil of turpentine and of pine tar. Large quantities of rosin oils are also employed in the preparation of printing inks, in the tarring of roads, and for injection into wood.

WATERTONE SEPIA PRINTING PAPER.

By JAMES THOMSON.

SEPIA watertone papers, simple to work and cheap withal, are not a novelty and to some it may seem superfluous for me to instruct the amateur worker as to a manner in which he may prepare such printing media for himself. The papers on the market are, it must be confessed, most convenient for the multitude, coming as such do, all nicely coated and cut to convenient sizes.

Some individuals there be too indolent to do anything for themselves, and from such the dealer will always reap a harvest, high cost being no bar to the customer's purchasing. Some there are on the other hand who buy the good thing only when it is cheap, and to such the sepia watertone paper now on the market will appeal, for it is both good and reasonable in price. But in addition to the people enumerated, there are many workers desirous of results removed from the common, and by sensitizing their own printing media, these individuals can be suited as regards quality and texture. Many are thus found printing pictures on specially selected papers leaving around the image (printed space) a generous margin, which imparts to their work much of the charm pertaining to the etching or engraving. In some notable examples the result has much of the refinement and quiet elegance of the wash drawing, looking anything but photographic.

For those, then, who sigh for such effects, and to meet the demands of those who aspire to print on note paper, postal cards, menu cards, and textile fabrics such as cotton, linen, silk, and the like, as well as parchment and various suitable brands of leather, I submit a formula giving fine sepia tones, and requiring nothing more than plain water for development, and weal hypo as a fixative. In fact, the manipulation is precisely the same as that advised for the Eastman sepia paper, and barring the hypo, is the identical procedure essential in the production of the blue print.

A rather close grained paper is in order, for when porous the elimination of the unreduced salts is difficult, even with a prolonged washing. Where "velvety" effects are desired, a generous application of size is imperative, and where keeping qualities are in view, linen paper must be employed. With the cheaper wood pulp stock one must in time expect deterioration, and the development of that sickly yellowness so noticeable in the cheap book.

Do not begrudge the price. The best paper is essential; high class bond or ledger stock, for example, being admirable for the purpose, provided there is a generous application of size to give softness to the image. Arrow-root size is among the best and may be prepared in the proportion of two grains of the powder to the ounce of water. Beat up with a little cold water in a bowl, adding balance of water hot. Bring to a boil, when the cloudiness will disappear, and the size be ready for use. During the past few years I have worked out more than a dozen sepia formulas. Some are slightly better than others, and among the best is the one I am about to submit.

SALTING SOLUTION.

Citrate of iron and ammonia	40	grains
Ferric oxalate, Merck's	15	grains
Oxalic acid	15	grains
Oxalate of potassium	30	grains
Citric acid	5	grains
Gum arabic	10	grains
Distilled water	1¼	ounces

Mix in the order given in a dark bottle, letting stand at least 12 hours before using. Apply with a flexible pad or wad of absorbent cotton, drying by the fire so as to keep the solution on the surface. When thoroughly dry, coat with the silver solution, which should be prepared as follows:

SILVER SOLUTION.

Nitrate of silver	55	grains
Citric acid	25	grains
Distilled water	1	ounce

When the chemicals are dissolved, this will be ready for use, and like the salting solution it should not be protected from light by keeping in a cool, dark place.

Coat with the silver solution and immediately dry by artificial heat. The best and most vigorous prints result from a thin, even coating of the salting solution, for when the latter is in excess the image is apt to have a muddy, bronzed appearance. The best results I have had by using rather small sheets of paper, and applying the solution quickly with a wad of absorbent cotton, drying immediately by the fire. This procedure is most essential when the rough surface or more porous papers are used. When the paper is hard and smooth, one may get better results by allowing the surface to become nearly dry before hastening with artificial heat.

Under print rather than over. Half tones should not be visible at all. Wash away the unaffected salts in clear water, from one to three minutes being sufficient. Then transfer to the cleaning bath, one and a half grains each of common salt and hypo to each ounce of water used. In this the print will rapidly darken, and in from 1 to 3 minutes, or when at its best, remove and wash for 20 or 30 minutes.

When the printing has been deep, longer fixing can do no harm, provided there is no bleaching of the half tones. Long fixing alters the color, usually having a darkening effect, and my own preference is for the colors obtained by short fixing as being more satisfactory in tone.

The formula here submitted is about right for the average pictorial negative, one rather thin but full of detail and fine gradation. For dense negatives a dilution of solution containing the iron will be necessary, while on the other hand strong vigorous prints may be obtained from these negatives by using but an ounce of water instead of an ounce and a quarter as per formula. If still more contrast is required add from four to eight drops of a five per cent solution of bichromate of potassium.

I would remark that success of the process demands the keeping of solution on the surface of the paper, for when too much sunk into the meshes the results are apt to be poor. This is more than likely to be the case when soft papers are used, therefore the importance of rapid drying. Experience can alone determine best conditions and quality of paper to employ, but for the novice the ledger paper or bond stock may be with confidence recommended, where the surface is slightly spontaneously dried, and is then completed by artificial heat.

It is a most pleasing variation where the solutions are with a wad of cotton applied with studied carelessness to the spot where the image is to be. In such a procedure when the sun has done its work we have a picture that has all the appearance of hand-brush work in sepia water-color. This is more likely to be the case where the outlines are not too abrupt, and experience can alone determine how this can be best effected.

As before mentioned, printing of this character can be done on postal cards, note paper, envelopes, menu cards, etc., the results depending greatly on the quality of the paper used as well as the sizing on same. Pure linen paper and arrowroot size will produce the most satisfactory results, but where pictures are for temporary purposes, or when simply experimenting, cheaper papers such as will be obtained all the way from 20 cents a pound at the stationer's will answer well enough.

Concerning postal cards, there is small use in attempting to print pictures on those issued by the government, the paper they are made from being so deplorably bad. Where postals made from good stock cannot be obtained at the stationer's, pictures may be printed on good paper and the regular postal card employed on which to mount them, the entire writing surface of the card being covered. By passing a hot iron over the card perfect adhesion and flatness will be assured.

Where printing on cloth is attempted it will be best to wash out the stiffness, as the size that gives body to so many textile fabrics contains chemicals that will impair the photographic image. Size well with a good solution of arrowroot or in lieu of that, plain starch. Sensitize and paste on a stiff piece of paper cut to the dimensions of your printing frame. In this way there will be no difficulty in keeping in register when examining from time to time to note progress of printing.

With the formula here exploited a few minutes in the sun will be sufficient with ordinary negatives, the printing capacity of the process being quite rapid. On this account it will be well with more than usually thin negatives to print under one or more sheets of tissue. It is a good plan to follow at all times when printing in direct sunlight, the image thus being more likely to be permanent, and always sharper and more decided regardless of other benefits.

Doubtless it may occur to some that if the two solutions were combined in one, the process would be ever so much simplified. Well, it is possible to combine the sensitizer with the salting solution, making good pictures thereby, but the results are not quite identical. Separate, the solutions keep better, and in my opinion the results are more uniform. Where the two are combined there is a heavy sediment, so each time the coating is attempted, the solution must be well shaken to thoroughly insure mixing of ingredients. However, for the benefit of labor savers, I submit a formula that will do the business in one application, and do it reasonably well.

SENSITIZER NO. 2.

Citrate of iron and ammonia	20	grains
Ferric oxalate	18	grains
Oxalate of potassium	20	grains
Gum arabic	10	grains
Silver nitrate	50	grains
Citric acid	25	grains
Distilled water	1	ounce

Mix the silver and citric acid in half of the water and the balance of ingredients in the remainder, combining the two after dissolving and shaking thoroughly. If found to be too strong, giving excessive contrasts, dilute with water, and when mixing a new lot, reduce the quantity of citrate and oxalate of iron, say two grains of each. It should always be borne in mind that prints dry out much darker than appearances while in the wash water would indicate. The following is suggested for strong negatives:

SENSITIZER FOR STRONG NEGATIVES.

Citrate of iron and ammonia	17	grains
Ferric oxalate	17	grains
Oxalate of potassium	18	grains
Gum arabic	10	grains
Silver nitrate	50	grains
Citric acid	23	grains
Water (distilled)	1	ounce

The pictures from these formulas are of a warm sepia, without a trace of fog, and all detail in the negative should appear in the print even in the highest lights.—Western Camera Notes.

AN ELECTRIC CHIME.

By the Late GEORGE M. HOPKINS.

NOTWITHSTANDING the fact that much of the music produced by chimes is rendered with discords and a clangor little less than barbarous, most people like this sort of music and are ever ready to listen to it. Possibly one reason for this is that this music is not so common as other kinds; another is that there is a kind of unwritten poetry about bells that appeals to everybody.

Tower chimes are for the public, and rich and poor alike can enjoy them, but smaller chimes are mainly for those who are able to purchase them, in fact, they may be classed among luxuries. However, house clock chimes bring bell music out of the list of the extraordinary and place it within the range of everyday home life. There is no reason why any one with a mechanical turn of mind cannot construct a chime without much expense. All that is needed is a lathe, a few tools and eight or ten ordinary hand bells. The bells are to be tuned so that when struck they will yield the notes of the diatonic scale. Tuning is a comparatively simple matter. If the workman does not happen to have a musical ear, he can procure the assistance of some one who has.

A fine bell made of genuine bell metal is one thing, and the ordinary hand bell sold at the hardware and house furnishing goods stores is quite another thing, still the latter afford the most available material for a chime, and withal answer a very good purpose.

The writer had the good fortune to find a dealer who was kind enough to allow him to select from a large number eight bells having approximately the required pitch for an octave, and two additional bells, one above and the other below the octave. These bells first of all had to be tuned to render them useful in a chime. This, although a simple operation mechanically, requires some skill in determining the pitch, as an ordinary bell generally yields two or more discordant notes.

The bell to be tuned is chucked on the lathe by

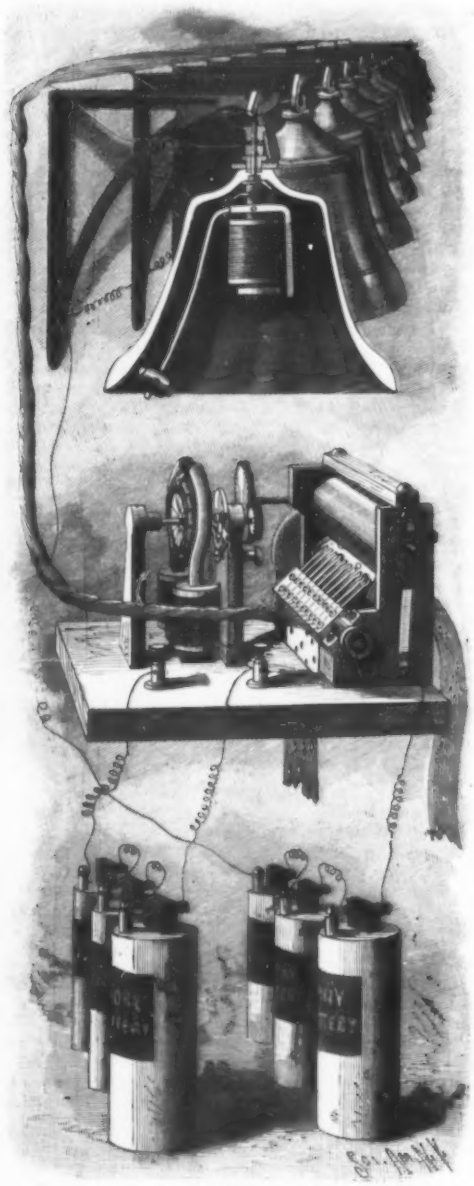


FIG. 2.—ARRANGEMENT OF THE BELL CIRCUIT.

means of a concave wooden chuck secured to the face plate. If the lathe has a hollow mandrel, the bell may be held in place by a long bolt extending through the bell and lathe mandrel. After the bell is centered, so that its rim runs true, a block is fitted to it at a point within the thicker portion of the rim and held in place by the tail stock of the lathe. This prevents vibration and the chattering of the tool; an ordinary hand brass-turning tool is used. If the pitch of the bell is too high, and it is required to lower it, the thick part of the rim is turned off on the line, *a*, as shown in Fig. 1. If, on the other hand, the pitch is too low, it is raised by turning off the edge of the rim on the line, *b*. Whenever it is desired to test the note of the bell, the block is removed and the bell is struck with a small wooden mallet. The note can be compared with that of a piano or other musical instrument, or the proper pitch can be arrived at by comparing the bells with each other. It is scarcely practicable to tune the chime to

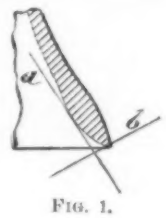


FIG. 1.

any particular key unless the majority of the bells are near the required pitch at the start.

After the bells are tuned they are each provided with an electric bell hammer, as shown in the first bell of the series in the upper part of Fig. 2. As this bell hammer is almost identical with that of an electric bell of comparatively recent invention, the writer in justice to himself must say that this electric bell was devised by him long before the bell alluded to was known to the public.

The magnet core is reduced in diameter at its upper end and extends through the aperture at the top of the bell and is threaded to receive two nuts, between which a wire is clamped. These wires from the several bells are connected with the contact springs or keys of the current-controlling mechanism shown at the center of Fig. 2. The core is insulated from the bell, and between the lower nut and the bell is clamped a yoke or loop which is in electrical contact with the bell, but insulated from the core. On the core is placed a bobbin wound with No. 24 wire. To the lower end of core is attached a pole extension, which reaches beyond the periphery of the bobbin and is provided with a short copper stud to prevent the sticking of the armature. To the core above the bobbin is pivoted the armature which extends downward over the side of the bobbin to a point opposite the pole extension. The armature is prolonged beyond its pivot and drilled to receive the hammer wire, which extends downwardly toward the mouth of the bell and carries a hollow metal hammer containing a wooden plug. The hammer is arranged to strike on the thicker portion of the bell rim. One terminal of the bobbin is connected with the magnet core, the other with the bell; each bell is supported by a bracket, the end of which enters the yoke or loop.

The brackets are connected together electrically and communicate through a wire with one pole of the battery, the other pole of which is connected with a spring which presses on the shaft of the metallic drum of the current-distributing machine. The springs before alluded to press on the cylinder through perforations in a strip of paper on which is arranged the music to be played. The springs are attached to a bar which may be turned back so as to remove the springs from the paper strip and the drum to facilitate the introduction of a new paper strip. Above the drum is placed a wooden roller, the gudgeons of which are pressed downward by springs—the roller being designed to insure sufficient friction of the paper to carry it with a positive motion through the machine. A worm wheel secured to the shaft of the metal drum is driven by a worm on a shaft extending at right angles to the drum and carrying a spur wheel which receives its motion from a pinion on the shaft of the electric motor. The motor is of the kind described in SUPPLEMENT No. 783, and will therefore require no detailed description here.

When the electric chime is connected with a clock, as shown in Fig. 3, it is necessary to provide a very long perforated paper strip or to employ a perforated endless paper belt, and to provide means for starting the motor at the proper time and stopping it when the piece is finished. The mechanism for doing this is shown diagrammatically in Fig. 4. In this case the let-off mechanism is arranged to operate every half hour, but, of course, it could be made so as to operate every quarter hour.

On the minute hand arbor are secured two cams, *a*, and to the frame of the clock is secured the spring arm, *B*, furnished with a triangular arm projecting into the path of the cams, *a*. The free end of the spring arm carries a weight, and in an insulating bar, placed between the arbor, *A*, and support of the spring arm, *B*, is inserted a contact screw, *C*. The spring arm, *B*, is held normally out of contact with the contact screw, *C*. When the arm, *B*, is raised by one of the cams, *a*, and released, the momentum of the weight attached to the free end of the arm carries the arm beyond its normal position and momentarily closes the circuit on the contact screw, *C*. The electrical contact is prolonged by virtue of the momentum of the weight and the bending of the spring arm.

The contact screw, *C*, is connected with one pole of the battery, and the remaining pole is connected with one terminal of the magnet, *D*, the other terminal being connected with the spring arm, *B*. The contact screw, *E*, is connected with the battery in parallel with the magnet, *D*, and a wire running from the battery is connected in parallel with the wire leading to the contact screw, *C*. This wire connects with the motor, *F*, which drives the paper-carrying drum, and also with the auxiliary contact spring, *c*. The paper strip has a single perforation, *f*, located at the end of the piece of music, through which the spring, *c*, may touch the cylinder. The armature lever, *d*, is pivoted midway between the magnets, *H D*, and it is held in either of the two positions it may assume by the double-acting spring, *e*.

When one of the cams, *a*, raises the spring arm, *B*, and allows it to fall, the current from the battery is momentarily sent through the magnet, *D*, thereby drawing over the armature, *b*, and bringing the contact spring carried by the armature lever into contact with the screw, *E*; and although the magnet, *D*, ceases to act when this is done, the spring remains in contact with the screw and the current flows from the battery to the screw, *E*, thence through the armature lever to the motor, *F*, and from the motor back to the battery. This starts the motor of the current-distributing mechanism, and the current is sent to the one or the other of the bells, according to the position of the holes in the paper strip.

When the end of the piece is reached, the spring, *c*, forms an electrical contact with the metallic drum through the hole, *f*, in the paper strip, *G*. The current from the battery then flows through the screw, *P*, and armature lever, *d*, to the magnet, *H* (whose resistance is somewhat less than that of the motor), thence through the metallic drum back to the battery. The armature, *b*, is thus drawn over to the magnet, *H*, and the circuit is broken when the motor stops, but all the parts are ready for another operation and the circuit of the battery is left open.

The contact springs are ¼ inch apart from center to center, consequently the longitudinal lines on the paper on which the holes are punched must be ¼ inch apart.

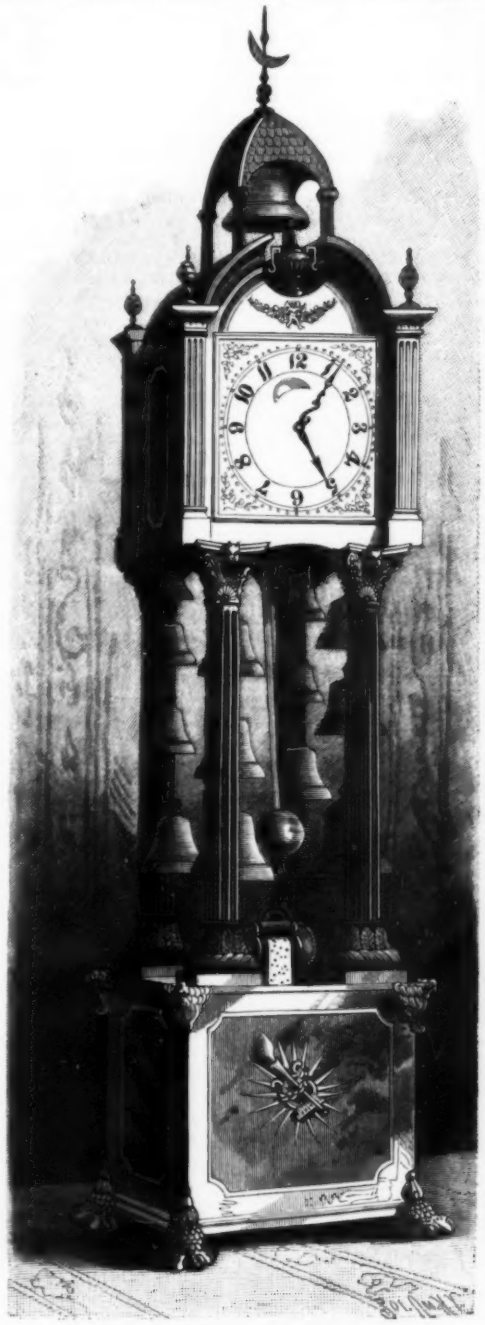


FIG. 3.—CLOCK WITH ELECTRIC CHIME.

The transverse or time divisions may be ¼ inch or more apart. The distance will depend on the speed of the motor and the character of the music. In the example shown in Fig. 5 the transverse lines are ¼ inch apart; the music being composed entirely of quarter notes permits of this arrangement. This example shows the beginning and the end of the tune "Vespers." The holes represent the position of the notes on the staff. It is a very simple matter to transfer any piece of music to a strip

of paper ruled in the manner indicated, it being only necessary to remember that on the position of the note in the scale depends the location of the hole on the transverse line, while the relative positions of the holes on the longitudinal lines determine the time and the length of the notes.

The following is the music of the Westminster

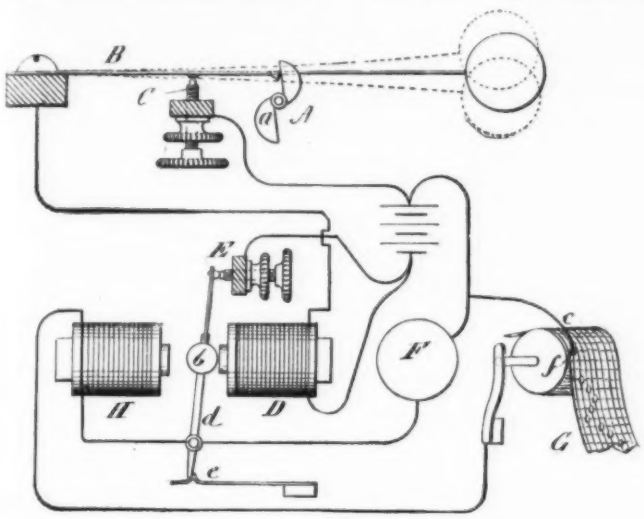


FIG. 4.—LET-OFF MECHANISM.

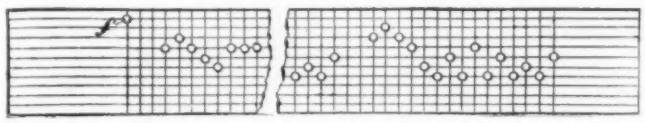


FIG. 5.—THE MUSIC.

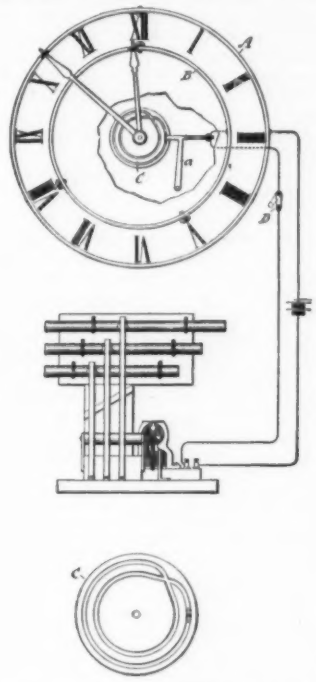


FIG. 6.—CHIME WITH CLOCK CONNECTION.

chimes for the first, second, and third quarter of the hour and the hour:

This music can be readily transferred to a strip of paper like that described. It is necessary to bear in mind that if, on paper divided as shown, one space represents the duration of a quarter note, two spaces would represent a half note, and four spaces a whole note.

To secure practice in mechanics or in electrical work, the amateur may as well construct something for actual use. A very useful and pleasing electro-mechanical device is an electric chime to be used as a door bell or call bell, or in connection with a clock. It serves its purpose as a call and gives an ever-changing series of harmonic notes.

The first step toward the construction of this device is to purchase the toy known as the tubophone, and select three of the tubes which produce a chord, or if the maker prefers it, he may buy a piece of mandrel drawn brass tubing, ⅝ inch external diameter, with walls 1/32 inch thick, and cut off three pieces respectively 7⅝, 8⅜, and 9⅜ inches in length; each of these should be laid upon two short pieces of soft woolen cord, with the cord touching at nodal points, that is, at exactly one quarter of the length from the end. Arranged in this way the tubes give out a clear note when struck with a small wooden mallet. By comparing these notes with those of a piano or other musical instrument, the tubes may be tuned. The pitch is raised by shortening the tube, but as there is no practical way of lowering the pitch after the tube has once been shortened, it would be advisable to cut the tubes a little longer than the measurements given. A baseboard having a short standard is provided, and to the upper portion of the standard is secured a board into which are driven three pairs of wire nails, the nails in each pair corresponding in position with the nodes of one of the tubes. The tubes are suspended from these nails by soft cords passing around the tubes at the nodes or points of no vibration, leaving the tubes free to vibrate at the center and at the ends.

Now it remains to construct the electro-mechanical device for striking the tubes. To the baseboard are secured the angled ends of three strips of spring brass, 7/32 inch wide and 1/32 inch thick, which extend above the tubes and carry small wooden mallets in position to strike the middle portion of each tube. The mallets are secured to the springs by means of ordinary wood screws passing through the springs into the mallets.

Behind the springs, at or near their mid-length, is placed a diagonal strip of wood, having secured to its outer edge a strip of felt or chamois skin. The spring strikes this piece and allows the mallet to strike the tube and spring back without jarring. Behind the springs is supported a small shaft on which is placed a wooden cylinder about 1 inch in diameter and 2½ inches long. In the cylinder and opposite the springs are inserted wire nails, arranged to strike short inclined strips riveted to the springs. The nails are placed so that they will strike the inclined strips in different orders; for example: 1, 2, 3; 3, 2, 1; 2, 3, 1; 1, 3, 2.

A toy electric motor having a three-pole armature

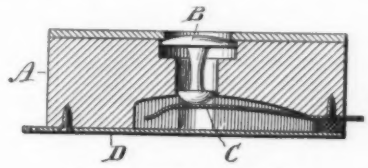


FIG. 7.—PUSH BUTTON.

is used for turning the cylinder, and two clock wheels and a pinion are employed for reducing the speed. A worm is placed on the armature shaft of the motor, which engages the first of the clock wheels. This worm may be cut in a lathe, but if this is inconvenient, a wire may be wound spirally around the armature shaft and soldered. It will, of course, be necessary to wind the spiral so that it will fit the teeth of the clock wheel, and the surplus solder should be scraped from the wire to diminish friction. The motor is provided with binding posts to receive the battery wires. One or two cells

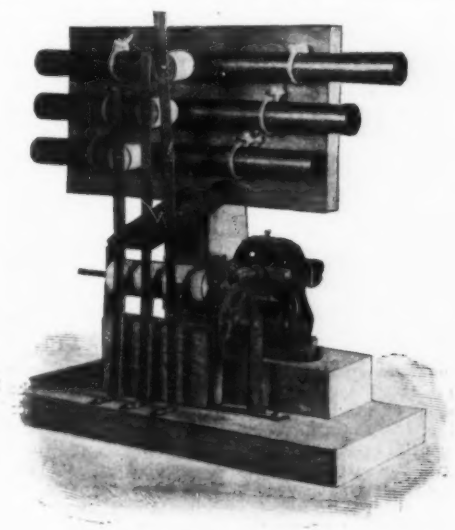


FIG. 8.—ELECTRIC CHIME.

of dry battery will run the chime. The chime is used in place of an ordinary call or door bell, or it may be used in connection with a clock, as shown, for making calls at certain hours.

The push button shown in the sectional view is made to close the circuit when the chime is used in place of a call bell or door bell. The button is readily made by boring a small block, *A*, of hard wood in two diameters to receive the head and back of the pearl collar button, *B*, the back of which is held in place by the apertured piece of veneering secured to the face of the block by small screws, while the head of the button rests on a curved brass spring, *C*, secured in a slot in the back of the block, *A*, by a screw. The outer end of the spring projects beyond the side of the block to receive one of the circuit wires. This slot is filled below the spring with insulating material, and a brass plate, *D*, is secured to the back of the block, *A*, and has upon one edge an apertured ear for receiving the other circuit wire. The plate, *D*, is secured to the back of the block by small screws. The free end of the spring, *C*, is curved over to a point near the brass plate, *D*, so that when the spring is depressed by pressing the button, *B*, it will touch the plate and close the circuit.

The annexed diagram shows an appliance which enables the chime to be used in connection with a clock. In front of the dial of an ordinary clock are secured the rings, *A*, *B*, made of 1/16 inch square brass wire. The supports are of insulating material, and the rings are concentric with the arbor carrying the hands. The hands are bent outwardly to permit of extending over the rings without touching them, and to insure the hands against electrical contact with the rings a thin short sleeve of paper is slipped over each hand near the free end. Each ring has several small radial holes bored in it to receive the brass nails, the heads of which project sufficiently beyond the front surface of the rings to enable the hands to touch them as they pass.

The circuit wires connecting the battery and the chime are connected one with the outer ring, *A*, the other with one of the springs of the cut-out switch shown in the opening formed by the breaking away of the dial. The other spring is connected with the inner ring, *B*. The springs are insulated from each other.

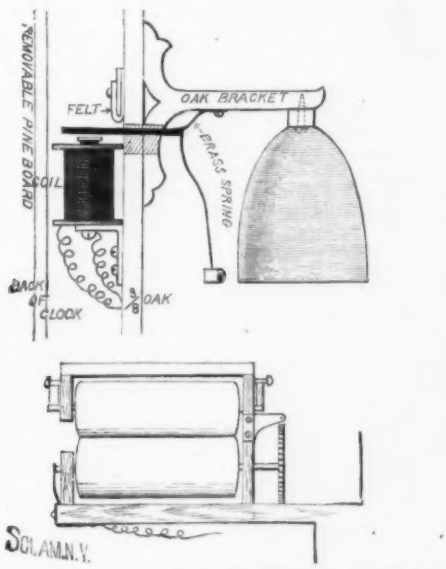
On the sleeve which carries the hour hand is mounted the crossed slotted cam, *C*, also shown detached in the larger figure. In the slot of this cam is a boat-shaped follower which slides easily in the slot and is longer than the width of the slot, so that it can, in following the slot, take the inner and outer portions of the slot in alternation. The following is pivoted to the angled lever, *a*, which is pushed by the cam between the parallel springs and withdrawn from them in alternation once in 12 hours. The object of this arrangement is to cut out the chime at night and put it in the circuit in the daytime. The cam, *C*, and the angled lever, *a*, are insulated from the clock movement.

A switch, *D*, is provided for throwing the device out of action at any time.

It will be seen that the hour hand must come into contact with the nail on the inner circle and the minute hand must touch the nail in the outer circle to complete the circuit, and cause the chime to sound. The duration of the chiming is limited by the time the minute hand is in contact with the nail. The clock when arranged as here shown sets off the chime at 8 o'clock, 12 o'clock and 5 o'clock. It is now about to ring the chime for 12 o'clock.

Note by the Editor.—We give an engraving of an electric chime clock made by one of our readers, after instructions given by Mr. Hopkins, the builder of which informs us that it works well and gives him a great deal of satisfaction.

Owing to the fact that the bells procured by him were too small to receive the electro-magnets, he placed them outside of the bells, in the manner illustrated in Fig. 9, the bells being suspended from brackets attached to a board at the back of the clock, the electro-magnets being secured to the rear surface of this board. The armature lever is attached to a spring, which serves as a pivot, and also retracts the armature after it has



FIGS. 9 AND 10.—DETAILS OF ELECTRIC CHIME CLOCK.

made a stroke. A small disk of felt is secured to the pole of the magnet and a loop of felt is attached to the back board. The armature plays between these two pieces of felt, and is, therefore, noiseless in its operation. The upper roller of the pair which moves the perforated paper is supported in an overhanging frame,

as shown in Fig. 10, so that an endless piece of music can be slipped between the rollers and played over and over.

The clock movement is an 8-day lever movement. This, being a compact form of clock, affords ample room for the favorable disposition of the bells and machinery. The case is of very neat design, made entirely of quartered oak, well filled and finished. The glass doors and sides are beveled. Taken altogether, it is as fine a piece of hall, dining room, or parlor furniture as one would wish to have.

HOW MANY GNATS OR MOSQUITOES ARE THERE IN A GIVEN AREA?

By Major RONALD ROSS.

WE can not anywhere state the exact number of mosquitoes to the square mile or yard, and we can not, therefore, accurately gage any local decrease which may have resulted from operations against them. A method of doing this may be invented in the future; but for the present we must employ another means for resolving the problem—one which has given such great results in physics—namely strict logical deduction from ascertained premises.

As another preliminary we should note that mosquito-reduction is only part of a larger subject, namely, that of the local reduction of any living organisms. Unlike particles of matter (so far as we know them) the living unit can not progress through space and time for more than a limited distance. The diffusion of living units must, therefore, be circumscribed—a number of them liberated at a given point will never be able to pass beyond a certain distance from that point; and the laws governing this diffusion must be the same for all organisms. The motile animal is capable of propelling itself for a time in any direction; but even the immotile plant calls in the agency of the winds and waters for the dissemination of its seeds. The extent of this migration, whether of the motile or the immotile organisms, must to a large degree be capable of determination by proper analysis; and the logical position of the question of local reduction depends upon this analysis.

The life of gnats, like that of other animals, is governed by fixed laws. Propagation can never exceed, nor mortality fall below, certain rates. Local conditions may be favorable either to the birth rate or to the death rate; and the local population must depend upon the food supply. Diseases, predatory animals, unfavorable conditions and accidents depress the density of population; and in fact local reduction, that is, artificial depression of the density of population, practically resolves itself into (a) direct destruction and (b) artificial creation of unfavorable conditions.

Let us now endeavor to obtain a perfectly clear picture of the problem before us by imagining an ideal case. Suppose that we have to deal with a country of indefinite extent, every point of which is equally favorable to the propagation of gnats (or of any other animal); and suppose that every point of it is equally attractive to them as regards food supply; and that there is nothing, such for instance as steady winds or local enemies, which tends to drive them into certain parts of the country. Then the density of the gnat population will be uniform all over the country. Of course, such a state of things does not actually exist in nature; but we shall nevertheless find it useful to consider it as if it does exist, and shall afterward easily determine the variations from this ideal condition due to definite causes. Let us next select a circumscribed area within this country, and suppose that operations against the insects are undertaken inside it, but not outside it. The question before us is the following: How far will these operations affect the mosquito density within the area and immediately around it?

Now the operations may belong to two categories—those aimed at killing the insects within the area, and those aimed at checking their propagation. The first can never be completely successful; it is in fact impossible to kill every adult winged gnat within any area. But it is generally possible to destroy at least a large proportion of their *larvæ*, which must live for at least a week in suitable waters, and which may easily be killed by larvacides, or by emptying out the waters, or by other means. This method of checking propagation consists, in the case of these insects, of draining away, filling up, poisoning or emptying out the waters in which they breed. Obviously the ultimate effect is the same if we drain away a breeding pool or if we persistently destroy the larvæ found in it; though in the first case the work is more or less permanent, and in the second demands constant repetition. If we drain a breeding area we tend to produce the same effect at the end of a year as if we had destroyed as many gnats as otherwise that area would have produced during that period. Thus, though we can not kill all mosquitoes within an area, even during a short period, we can always arrest their propagation there for as long as we please, provided that we can obliterate all their breed waters or persistently destroy all their larvæ—which we may assume can generally be done for an adequate expenditure. We must, therefore, ask what will be the exact effect of completely arresting propagation within a given area under the assumed conditions?

The first obvious point is that the operation must result in a decrease of mosquitoes. If we kill a single gnat there must be one gnat in the world less than before. If we kill a thousand every day there must be so many thousands less at the end of a given period; and the arrest of propagation over any area, however small, must be equivalent to the destruction of a certain number of the insects. But this does not help us much. It may be suggested that, after the arrest of propagation over even a considerable area, the diminution of mosquitoes within the area remains inappreciable. What is the law governing the percentage of diminution in the mosquito density due to arrest of propagation within an area?

The number of gnats (or any animal) within an area must always be a function of four variables, the birth rate and death rate within the area, and the immigration and emigration into and out of it. If we could surround the area by an immense mosquito bar, the insects within it (after the death of old immigrants) would consist entirely of native insects; on the other hand, if we arrest propagation, the gnat population must hereafter consist entirely of immigrants. The question, therefore, resolves itself into this one: What is—what must be—the ratio of immigrants to natives within an area? What factors determine that ratio?

Ceteris paribus, one factor must be the size of the area. If the area be a small one, say of ten yards radius, suppression of propagation will do little good, because the proportion of mosquitoes bred there will be very small (under our assumed conditions) compared with those which are bred in the large surrounding tracts of country, and which will have no difficulty in traversing so small a distance as ten yards. But if we completely suppress propagation over an area of ten miles radius, the case must be very different—every gnat reaching the center must now traverse ten miles to do so. And if we increase the radius of the no-propagation area still further, we must finally arrive at a state of affairs when no mosquitoes at all can reach the center, and when, therefore, that center must be absolutely free from them. In other words, we can reduce the mosquito density at any point by arresting propagation over a sufficient radius around that point.

But we now enter upon more difficult ground. How large must that radius be in order to render the center entirely mosquito-free? Still further, what will be the proportion of mosquito reduction depending upon a given radius of anti-propagation operations? What will be that proportion, either at the center of operations, or at any point within or without the circumference of operations? The answer depends upon the distance which a mosquito can traverse, not during a single flight, but during its whole life; and also upon certain laws of probability, which must govern its wanderings to and fro upon the face of the earth. Let me endeavor to indicate how this problem, which is essentially a mathematical one of considerable interest, can be solved.

Suppose that a mosquito is born at a given point, and that during its life it wanders about, to and fro, to left or to right, where it wills, in search of food or of mating, over a country which is uniformly attractive and favorable to it. After a time it will die. What are the probabilities that its dead body will be found at a given distance from its birthplace? That is really the problem which governs the whole of this great subject of the prophylaxis of malaria. It is a problem which applies to any living unit. We may word it otherwise, thus: Suppose a box containing a million gnats were to be opened in the center of a large plain, and that the insects were allowed to wander freely in all directions, how many of them would be found after death at a given distance from the place where the box was opened? Or we may suppose without modifying the nature of the problem that the insects emanate, not from a box, but from a single breeding pool.

Now what would happen is as follows: We may divide the career of each insect into an arbitrary number of successive periods or stages, say of one minute's duration each. During the first minute most of the insects would fly toward every point of the compass. At the end of the minute a few might fly straight on and a few straight back, while the rest would travel at various angles to the right or left. At the end of the second minute the same thing would occur—most would change their course and a very few might wander straight on (provided that no special attraction exists for them). So also at the end of each stage—the same laws of chance would govern their movements. At last, after their death, it would be found that an extremely small proportion of the insects have moved continuously in one direction, and that the vast majority of them have wandered more or less backward and forward and have died in the vicinity of the box or pool from which they originally came.

The full mathematical analysis determining the question is of some complexity; and I can not here deal with it in its entirety. But if we consider the lateral movements as tending to neutralize themselves, the problem becomes a simple one, well known in the calculus of probabilities and affording a rough approximation to the truth. If we suppose that the whole average life of the insects contains n stages, and that each insect can traverse an average distance l during one such stage or element of time, then the extreme average distance to which any insect can wander during the whole of its life must be nl. I call this the limit of migration and denote it by L, as it becomes an important constant in the investigation. It will then be found that the numbers of insects which have succeeded in reaching the distances nl, $(n-1)l$, $(n-2)l$, etc., from the center will vary as twice the number of permutations of $2n$ things taken successively, none, one, two, three at a time, and so on—that is to say, as the successive coefficients of the expansion of $2^n n$ by the binomial theorem. Suppose, for convenience, that the whole number of gnats escaping from the box is $2^n n$—a number which can be made as large as we please by taking n large enough and l small enough—then the probabilities are that the number of them which succeed in reaching the limit of migration is only 2; the number of those which succeed in reaching a distance one stage short of this, namely, $(n-1)l$, is $2.2n$; of those which reach a stage one shorter still is

$$2\,\frac{2n(2n-1)}{2!}$$

and so on. Hence the whole number of gnats will be found arranged as follows:

Distance from center	nl	$(n-1)l$	$(n-2)l$	$(n-3)l$	etc.	total.
Number of gnats	$2 +$	$4n +$	$\frac{2n(2n-1)}{2!} + 2$	$\frac{2n(2n-1)(2n-2)}{3!} +$	etc.	$= 2^{2n}$

It, therefore, follows from the known values of the binomial coefficients that if we divide the whole number of gnats into groups according to the distance at which their bodies are found from the box, the probabilities are that the largest group will be found at the first stage, that is close to the box, and that the successive groups, as we proceed further and further from the box, will become smaller and smaller, until only a very few occur at the extreme distance, the possible limit of migration. And the same reasoning will apply to a breeding pool or vessel of water. That is, the insects coming from such a source will tend to remain in its immediate vicinity, provided that the whole surrounding area is uniformly attractive to them.

The following diagram will, I hope, make the reasoning quite clear.

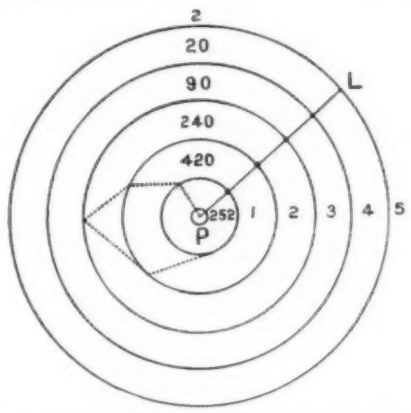


DIAGRAM I.—THE CHANCE-DISTRIBUTION OF MOSQUITOES.

P, central breeding pool. *L*, limit of migration. The numbers denote the proportions of 1,024 mosquitoes starting from *P* which die at the distances 1, 2, 3, 4, 5, respectively. The continuous line denotes a continuous migration always in one direction; the dotted line, the usual erratic course.

We suppose that 1,024 mosquitoes have escaped during a given period from the central breeding-pool *P*, and we divide their subsequent life into 5 stages—the numbers 1,024 and 5 being selected merely for illustration. Rings are drawn around the central pool in order to mark the distance to which the insects may possibly wander up to the end of each stage; and the continuous line shows the course followed by one which has wandered straight onward all its life and has died at the extreme limit to which an insect of its species can generally go, namely, the outermost circle, *L*. On the other hand, the dotted line shows a course which is likely to be followed by the largest number of the 1,024 insects liberated from the pool—that is to say, a quite irregular to-and-fro course, generally terminating somewhere near the point of origin. The numbers placed on each ring show the number of mosquitoes calculated from the binomial coefficients when $n = 5$, which are likely to reach as far as that ring at the time of their death. Thus only 2 out of the 1,024 mosquitoes are ever likely to reach the extreme limit; while, on the other hand, no less than 912, or 89 per cent, are likely to die somewhere within the second ring around the center.

The same reasoning will apply whatever may be the number of mosquitoes liberated from the pool, or the number of stages into which we arbitrarily divide their subsequent life. Suppose, for example, that 1,048,576 mosquitoes escape from the pool and that we divide their life into 10 stages. Then only two of all these insects are ever likely to reach the extreme limit of the outermost circle; only 40 will die at the next circle; only 190 at the next; and so on—the large majority perishing within the circles comparatively close to the point of origin.

This fact should be clearly grasped. The law here enunciated may, perhaps, be called *the centripetal law of random wandering*. It ordains that when living units wander from a given point *guided only by chance* they will always tend to revert to that point. The principle which governs their to-and-fro movements is that which governs the drawing of black and red cards from a shuffled pack. The chances against our drawing all the twenty-six black cards from such a pack without a single red card among them are enormous; as are the chances against a mosquito, guided only by chance, always wandering on in one direction. On the other hand, just as we shall generally draw black and red cards alternately from the pack, or nearly so, so will the random movements of the living unit tend to be alternately backward and forward—tend, in fact, to

keep it near the spot whence it started. As there is no particular reason why it should move in one direction more than another, it will generally end by remaining near where it was.

But it will now be objected that the movements of mosquitoes are not guided only by chance, but by the search for food. To study this point, take the diagram just given, place a number of pencil dots upon it at random, and suppose that each pencil dot denotes a place where the insects can obtain food—suppose, for example, that the breeding pool lies in the center of a large city and that the pencil dots are houses around it. Consideration will show that the centripetal law must still hold good, because there is no reason why the insects should attack one house more than another. There is no reason why a mosquito which has flown straight from the pool to the nearest house should next fly to another house in a straight line away from the pool, rather than back again, or to the right or left. The same law of chance will continue to exert the same influence, and the insects will always tend to persecute most those houses which lie in the immediate vicinity of their breeding pool. Even when there are many pools scattered about among the houses, there is no reason why, after feeding, the mosquitoes will go to one rather than to another, and the result must be that in general they will tend to remain where they were.

Self-evident as this argument may now appear, it is not understood by many who write on the subject and who seem to think that mosquitoes radiate from a center and shoot forever onward into all parts of the country as rays of light do. Accepting this fallacy without question, they argue that it is useless to drain local breeding pools because of the influx of mosquitoes from without. Such an influx certainly always exists, but I shall now endeavor to show that it can not generally compensate for local destruction.

Let us consider a tract of country over which numbers of mosquito-breeding pools are scattered, with houses and other feeding places lying among them. Suppose we draw a straight line across this country and drain away all the pools to the right of it, leaving all those to the left of it intact. Then all the insects on the left of the line must be natives of that part; and all those on the right of it must be immigrants which have crossed over the line from the left. How many mosquitoes will there now be on the right side, compared with those on the left side? The following diagram will enable us to consider this question more conveniently.

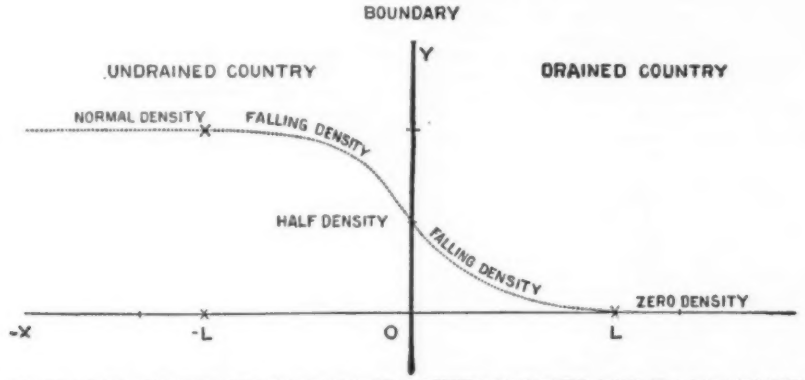


DIAGRAM II.—CURVE OF FALLING MOSQUITO-DENSITY DUE TO DRAINAGE ON RIGHT OF BOUNDARY.

L and *-L* are the limits of migration on either side of the boundary.

First, examine the state of affairs before the drainage was effected. We may suppose that mosquitoes were then breeding fairly uniformly over the whole country, and that their density was much the same on both sides of the line. A certain amount of migration across the line, both from right to left and from left to right, must always have been going on; and since the density was equal on both sides, this migration must also have been *equal and opposite*—that is, as many emigrants must have been constantly passing from right to left as from left to right. Now, after the drainage has been effected, the following changes occur. The insects breed as before on the left of the line, and some continue as before to cross over it into the drained country; but, in the latter, on the right of the line, propagation is entirely checked and, moreover, the migration from it to the left of the line, which used to exist, now ceases. Hence not only must there be a decrease of mosquito-density on the right of the line, due to the local cessation of breeding, but also a decrease on the left of the line, due to the cessation of the migration from the right which formerly took place—that is to say, the drainage has affected the mosquito-density not only up to the line of demarkation, but beyond it. And moreover, since the migration was formerly equal from both sides of the line, it follows that now, after the drainage, the loss on the left side of the line due to the cessation of immigration from the right is exactly equal to the gain on the right due to the continuance of the immigration from the left. That is to say, the mosquitoes gained by immigration into the drained country must be exactly lost by the undrained country. This fact can be seen to be obviously true if we imagine an immense mosquito bar put up along the line of demarkation so as to check all migration across it, when, of course, the mosquito-density would remain as at first on the left, and would become absolute zero on the right; then on removing the mosquito-bar an overflow would commence from left to right, which would increase the density on the right by exactly as much as it would reduce the density on the left.

The dotted line on the diagram indicates the effect on the mosquito-density which must be produced by the drainage. If *L* is the possible limit of migration of mosquitoes (it may be one mile or a hundred, for all we know), the effect of the drainage will first begin to be felt at that distance to the left of the boundary line. From this point the density will begin to fall gradually until the boundary is reached, when it must be *exactly one half the original density*. This follows because of the equivalence of the emigration and immigration on the two sides. Next, as we proceed from the boundary into the drained country, the density continues to fall, until at a distance *L* on the right of the line, it becomes zero, the country now becoming entirely free of mosquitoes because they can no longer penetrate so far from the undrained country.

In the diagram the line giving the mosquito-density falls very slowly at first, and then, near the boundary, very rapidly, subsequently sinking slowly to zero. The mathematical analysis on which this curve is based is too complex to be given here; but it is not difficult to see that the centripetal law of random migration must determine some such curvature. The mosquitoes which are bred in the pools lying along the boundary line must remain for the most part in its proximity, only a few finding their way further into the drained country, and only a very few reaching, or nearly reaching, the limit of migration. Though an infinitesimal proportion of them may wander as far as ten, twenty or more miles into the drained country (and we do not know exactly how far they may not occasionally wander) the vast bulk of the immigrants must remain comparatively close to the boundary. And as, for the reason just given, the mosquito-density on the boundary itself must always be only one half the original density, it follows that it must become very rapidly still less, the further we proceed into the drained country. In fact, the analysis shows that the total number of emigrants must be insignificant when compared with the number of insects which remain behind—that is, when they are not drawn particularly in one direction. We are, therefore, justified in concluding that, as a general rule, the number of immigrants into any area of operations must, for practical purposes, be very small or inappreciable a short distance within the boundary line.

Diagram III. probably represents with accuracy the effects of thorough suppression of propagation within a circular area.

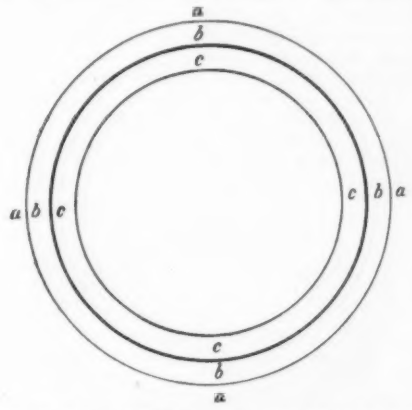


DIAGRAM III.—EFFECT OF DRAINAGE OF A CIRCULAR AREA.

b = boundary of drained area. Mosquito-density begins to diminish at the circle *a*; becomes one-half at the boundary *b*; and is small, inappreciable or zero at the circle *c*.

At the circle *a* and beyond it the mosquito density will be the normal density which existed before the operations were commenced. At *b*, the circle bounding the drainage operations, the density will always be about half the normal density. At the circle *c* and within it, the density will be small, inappreciable or zero. The distance from *a* to *b* may be taken as being the same as that from *b* to *c*; and, as the mosquitoes penetrating from *b* to *c* must be drawn from the zone between *a* and *b*, the *average* result will be the same as if no immigration at all takes place. We do not possess sufficient data to enable us to calculate the actual distance between *a*, *b* and *c*—this will depend in a certain measure on the activity of the species of insect concerned and on the existence or absence of special local attractions; but this fact does not discredit the general principles involved.

One case has not yet been considered, namely, that in which there exists only a single feeding place in the whole tract of country—such, for instance, as a single house or group of houses situated in the midst of deserted swamps. In such a case the insects may be compelled to come from considerable distances—from as far as their senses are capable of guiding them—in search of food; and drainage operations carried on with a view to relieving such a house may, for all we know, have to be extended over miles. But such cases are not of great consequence, because drainage is seldom the appropriate measure for isolated dwellings, which can generally be protected at far less cost by means of gauze screens. Moreover, it is very doubtful whether feeding places for mosquitoes are ever so solitary as the case assumes. Where there is one dwelling there are generally many, scattered at various distances over the country; and the insects are known to feed on cattle, birds, and other animals. For towns, where anti-mosquito measures are most demanded, our first assumed condition of uniform attractiveness must, as a rule, be the one in force; and in such cases the centripetal law will hold.

The effect of wind required examination. Theoretically, if the insects are supposed always to remain on the wing, wind blowing on a generating pool will merely have the effect of drifting the whole brood to a certain extent in one direction without changing the *relative* positions of the insects to each other. The result would be the same as indicated in Diagram I., except that the generating pool would now be eccentric. If a proportion of the insects take shelter, the circles of Diagram I. would become ellipses with the generating pool as a focus. In such a case the wind, and especially devious winds, would have a distributive tendency; but it must be remembered that if the insects are scattered farther apart their numbers at a given point must be reduced. A wind which blows mosquitoes into an area must blow others out of it. The net result of devious winds on a circular drained area would be that the mosquito-density is not so much reduced at the center, but is reduced to a greater distance outside the boundary circle—so that the average reduction remains the same. With a wind blowing continuously from one direction, the indication would be to extend the drainage further in that direction. Obviously, wind may scatter mosquitoes; but it cannot create them, nor prevent the total average reduction due to anti-propagation measures, as some people seem to think. It is, however, very doubtful whether wind does really drive or scatter mosquitoes to any great degree. In my experience they are extremely tenacious of locality. Thus *Anopheles* were seldom seen on Tower Hill, a low open hill in the middle of Freetown, Sierra Leone, although numerous generating pools existed a few hundred yards from the top, all around the foot of it, and the winds were often very strong. If a continuous wind can drive mosquitoes before it, then during the southwest monsoon in India they should be driven away from the west coast and massed toward the east coast; but I have never heard that they are at all less numerous on the west coast. I have often seen very numerous mosquitoes on bare coasts exposed to strong sea-breezes, as at Madras. As a rule, they seem to take shelter in the presence of a strong breeze. Instances of their being driven far by winds are frequently quoted, but in my opinion they were more probably bred, in many such cases, in unobserved pools close at hand. The wind-hypothesis is frequently used by municipal officials as an excuse for doing nothing—it is convenient to blame a marsh miles distant for propagating the mosquitoes which are really produced by faulty sanitation in the town itself.

Another and similar statement is often made with all gravity to the effect that mosquitoes are brought into towns in trains, carts, and cabs. So they are; but a moment's reflection will assure us that the number introduced in this manner must always be infinitesimal compared with those that fly in or which are bred in the town itself. Moreover, if vehicles may bring them in they may also take them out.

I will now endeavor to sum up the arguments which I have laid before you—I fear very cursorily and inadequately. First I suggested that there must be for every living unit a certain distance which that unit may possibly cover if it continues to move all its life, with such capacity for movement as nature has given it, always in the same direction. I called this distance the limit of migration. It should, perhaps, be called the ideal limit of migration, because scarcely one in many billions of living units is ever likely to reach it—not because the units do not possess the capacity for covering the distance, but because the laws of chance ordain that they shall scarcely ever continue to move always in the same direction. Next I endeavored to show that, owing to the constant changes of direction which must take place in all random migration, the large majority of units must tend to remain in or near the neighborhood where they were born. Thus, though they may really possess the power to wander much further away, right up to the ideal limit, yet actually they always find themselves confined by the impalpable but no less impassable walls of chance within a much more circumscribed area, which we may call the practical limit of migration—that is, a limit beyond which any given percentage of units which we like to select do not generally pass. Lastly I tried to apply this reasoning to

the important particular case of the immigration of mosquitoes into an area in which their propagation has been arrested by drainage and other suitable means. My conclusions are:

1. The mosquito-density will always be reduced, not only within the area of operations, but to a distance equal to the ideal limit of migration beyond it.

2. On the boundary of operations the mosquito-density should always be reduced to about one half the normal density.

3. The curve of density will rise rapidly outside the boundary and will fall rapidly inside it.

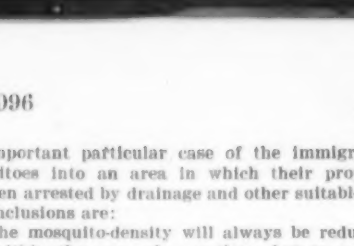
4. As immigration into an area of operations must aways be at the expense of the mosquito population immediately outside it, the average density of the whole area affected by the operations must be the same as if no immigration at all has taken place.

5. As a general rule for practical purposes, if the area of operations be of any considerable size, immigration will not very materially affect the result.

In conclusion, it must be repeated that the whole subject of mosquito-reduction cannot be scientifically examined without mathematical analysis. The subject is really a part of the mathematical theory of migration—a theory which, so far as I know, has not yet been discussed. It is not possible to make satisfactory experiments on the influx, efflux and varying density of mosquitoes without such an analysis—and one, I may add, far more minute than has been attempted here. The subject has suffered much at the hands of those who have attempted ill-devised experiments without adequate preliminary consideration, and whose opinions or results have seriously impeded the obviously useful and practical sanitary policy referred to. The statement, so frequently made, that local anti-propagation measures must always be useless, owing to immigration from outside, is equivalent to saying that the population of the United States would remain the same, even if the birth rate were to be reduced to zero. In a recent experiment at Mian Mir in India the astounding result was obtained that the mosquito-density was, if anything, increased by the anti-propagation measures—which is equivalent to saying that the population of the United States would be increased by the abolition of the birth rate. It is to be hoped that if such experiments are to be repeated they will be conducted by observers who have considered the subject. In the meantime, I for one must continue to believe the somewhat self-evident theory that anti-propagation measures must always reduce the mosquito density—even if the results at Havana, Ismailia, Klang, Port Swettenham, and other places are not accepted as irrefragable experimental proof of it.—Read before the International Congress of Arts and Sciences.

CURVES IN PATTERN-WORK.

IT is obvious that if curves of large size are cut in solid stuff, the grain must be short in places—an extreme illustration of which would be the turning of a



No. 1.

ring in solid stuff with resulting short grain at two opposite sides—whence two evils would result, namely, shrinkage in one direction and not in the other, and liability to become broken along the short grain. The pattern-maker is constantly meeting with cases of this kind, and others akin thereto. Machine and engine

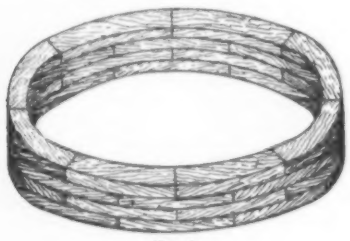


FIG. 2.

framings, and various parts of mechanisms abound with curved portions, the proper economical construction of which calls for settlement. The cheapest way of course is to cut them out of solid stuff, the exceptions occurring when a great deal of timber would have to be cut away to waste. But this is seldom done, except in the case of very rough work of a very temporary character, in which the timber would retain its truth just long enough to allow of a mold or two being made from it. Between this crude method and the very perfect devices adopted in building up patterns for permanent service, there are intermediate stages in which economy is sought, consistently with a reasonable degree of permanence.

When pattern outlines are curved, making the grain short, the proper plan to adopt is to joint up, and if the thickness is considerable, to make that thickness in more than one layer of segments. Thus, for example, pipe and column flanges are in ordinary cases turned from solid plank or board, whether they are made in halves to mold edgewise, or as rings to be left loose, molding flatwise. But no flanges over about 2 feet in diameter should be cut from the solid, because they are certain to shrink and go convex within a few days after being turned, and at two opposite sections also the grain is short and weak. Above that size they should be built up in from two to four thicknesses of

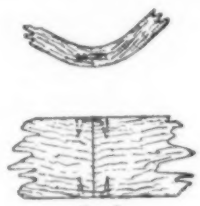


FIG. 3.

segments. Fig. 1 shows a large flange as made for a turbine tube, of a single thickness of segment only, framed with half-lap joints; but it would be stronger still if made in two or three thicknesses of segments with overlapping joints. The method shown is suitable for flanges ranging from 3 feet to 6 feet in diameter, and these will easily stand a few dozens of moldings.

Fig. 2 shows how a ring is built up with segments. The illustration is suitably proportioned for rings of

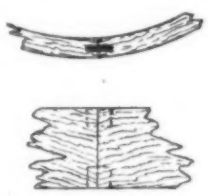


FIG. 4.

small and medium size. Very large ones would have a larger number of segments. Obviously to attempt to economize labor by using a few long thick segments rather than a larger number of shorter, thinner ones, defeats in some degree the advantage gained by building up, because some local shrinkage will occur in a large segment. The principle is to so multiply the number of segments used that the shrinkage (or swelling due to moisture) in each shall be inappreciable. So, too, in gluing, the glue used must not be old, but freshly made, and though thin, not watery. In the course of years glue loses much of its adhesive strength,

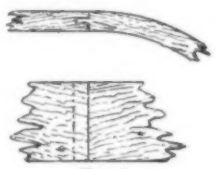


FIG. 5.

and the rapping of the pattern will then start the joints, even though well made originally. For this reason it is usual to reinforce the glued joints in rings and sweeps with wooden pegs, or with wire nails.

In standard pattern-work rings even so small as 5 inches or 6 inches diameter should be built up as in Fig. 2. But when below that size it is a usual practice to turn them in solid, well seasoned mahogany, and protect the grain with plenty of varnish.

The curved ribs of patterns, which are analogous to rings, are so constructed as to avoid short grain, being made either by means of segments built up one over the other as in complete rings, or in short lengths cut from solid stuff, and fitted together with abutting joints

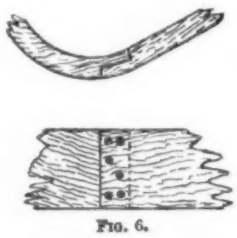


FIG. 6.

of various kinds. Figs. 3 to 6 show how short grain is avoided by the employment of abutting sweeps, the diagrams illustrating different modes of union employed. Thus in Fig. 3, wire dogs are used, or sometimes skew nails are driven in. In Fig. 4 hoop iron is let into saw kerfs, from each face only, or right down. In Fig. 5 a wooden tongue runs the whole depth. In Fig. 6 a half lap joint is made—the last two being the best methods. In deep sweeps overlapping of edges is likely to occur in Fig. 3, away from the dogs, and also in Fig. 4, away from the coercion exercised by the hoop iron—a reason why the latter should fit down the entire depth in a continuous saw-kerf. In Fig. 5, the tongue and groove is the best and neatest method. Fig. 6 is a little more secure, but not so neat in appearance.

The strongest mode, however, of making a sweep is that shown in Fig. 7, in which it is built up in thin segments like a ring. It may then be united either by means of a lap joint as in Fig. 6, to the straight portions, or else with tongues as in Fig. 7, which may be of wood, or of hoop iron. Or the straight portions, if

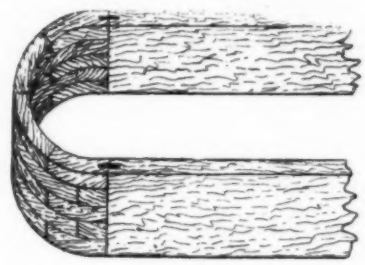


FIG. 7.

not very long, are sometimes built up with the sweep in strips, which is the strongest method of all. The body of a gas-valve pattern would be constructed in this manner, and the principle is carried out in other classes of work. Interlocking joints are thus substituted for abutting ones, which, unless made carefully, are apt to shift and overlap in the rough usage of the foundry.

Fig. 8 shows how massive work of curved outline, such as is usually cored out, can be framed together.

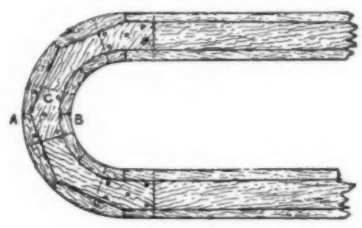


FIG. 8.

Deep blocks, *A*, are abutted end to end, and retained in place with the top and bottom boards: or an inner and outer arc of segments, as at *B*, can be built up, these also being retained by the flat pieces at top or bottom. The latter is the stronger and more durable; the former is substantial and inexpensive. To a certain extent the choice of *A* or *B* depends on the nature of the job. Single blocks like *A*, running the whole depth, are suitable for most boxed-up work that has to be cored out, because the top and bottom pieces maintain the

FIG. 9. FIG. 10.

blocks truly, and the outside faces alone are molding faces. In cases where the pattern delivers its own core segments should be built up as at *B*.

The top and bottom-plated portions, *C*, it will be observed, are not prepared in one piece, but are framed with half-lap joints to minimize shrinkage. Other curved portions of patterns are the hollows or fillets which are inserted in right and other angles. The insertion of these fillets does not add very materially to the strength of a pattern; but they are highly essential in the castings as elements of strength and elasticity. Figs. 9 and 10 are examples which occur with frequency, the first being a section through a ribbed pattern, the second being a corner of an open-plated framing. Fig. 11 is a method alternative with Fig. 10, fitted thus with a view to prevent the lifting up of the feather edges in Fig. 10. Fig. 12 illustrates

FIG. 11. FIG. 12.

a curving corner of a pattern of large radius, and Fig. 13 shows how the block for the curve is first glued in the square framing, and marked out in readiness for working.

Coming to cylindrical work: If we take a column or pipe of large diameter—say, over 6 inches or 8 inches—and make it of solid stuff, then after it has been in the stores for a few months it will frequently be seen to have warped like Fig. 14, being convex in the joint and lapping at the edges. Hence the need for building up. A cheap mode of doing so is to glue three pieces together, as in Fig. 15 (*A* being cross-pieces at the ends only). Using dry material, such patterns are fairly reliable for permanent use. The best patterns should,

however, be lagged-up, as in Fig. 16, by the adoption of which method it is evident that any shrinkage will be localized in each individual piece of lagging. The cross-pieces, *A*, upon which the lagging strip is built, are placed at intervals of from 9 inches to 12 inches.

The permanence of a lagged-up pattern depends part-

FIG. 13.

FIG. 14.

ly on the number of the cross-bars, partly on the thickness of the strips, and partly on the closeness of the joints. Thin, wide strips fastened on narrow cross-bars, situated a long way apart, produce a flimsy pattern that will not retain its truth, and that is sure to be rammed atwist. A built-up pattern should be as rigid when constructed as one made from solid stuff, which is insured by using thick cross-bars placed at

FIG. 15.

FIG. 16.

reasonable distances apart, making the strips fairly thick, narrow rather than wide, jointing closely, and gluing well. Dimensions, of course, are relative, depending on the size of the work. Fig. 17 illustrates several points relative to the arrangement of the grain in piecing-up patterns of this type, which will be generally applicable to this kind of work. The example is that of a column pattern, one-half of which is shown open in the joint face.

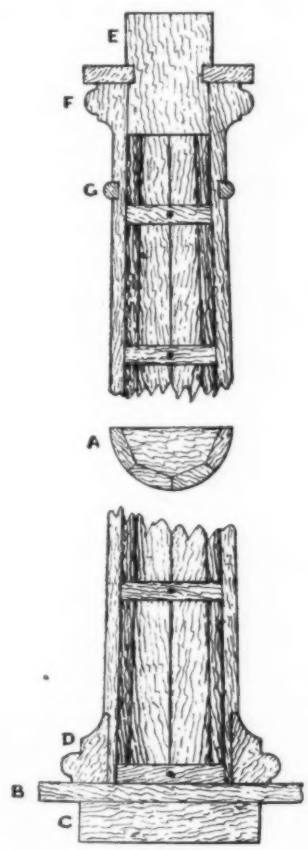


FIG. 17.

The main body of the column is built up with lagging-strips, shown in section at *A*. There is also a flange *B*, a print *C*, and a molding *D*, at the base. Because the print is large, by reason of the core having to follow the enlarged outline of the base, the stuff in the pattern body is shown as terminating with the end cross-bar, the flange *B* abutting against it, and the print *C* being screwed against the flange. The print *E*, at the opposite end, is smaller than the body, which

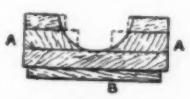


FIG. 18.

explains why the block of wood, *E*, is glued on the end of the pattern; or, more strictly speaking, the lagging strips are built around the block *E*, and the top flange fits into a groove turned in this block. If, on the other hand, the diameter of the core had been about the same as that of the pattern body, or only a trifle less, dependent, of course, on the outline of the molding, the manner in which it is cored out, and the size of the hole required in the flange, the column lagging would have been continued to include the print. These three alternative methods are in common use, strength and stability being the considerations to be borne in mind in the arrangement of the material.

So, again, if a molding is large, as at *D*, it is not made in one, or solid with the lagging, but as a separate piece preferably built up in segments or in short lagging strips, and made to fit into a shallow recess turned on the column. If it is small, as shown at *F*, blocks of wood are glued on the lagging, the grain in each running in the same direction, and so turned in one with the column body. A simple bead like *G* is turned as a ring, and either screwed on, or sunk into a groove.

Fig. 18 is an example of building up of another kind, being a half core-box built of strips, and battened. It is better in every respect, and less timber is employed when it is blocked up, as shown at *A A*, and battened across the back as at *B*, than when solid stuff is used. Large boxes are sometimes lagged up similarly to Fig. 16, reversed, but Fig. 18 is the general construction, saving timber and lessening liability to shrink.

Since the value of all building up consists in the diminution of shrinkage and twist, and in the crossing and strengthening of grain, it is now evident that wthin reasonable limits the more numerous the parts which enter into construction of the kinds shown the more durable will the patterns be. If segments are thick relatively to the size of their pattern, they will soon begin to start at the joints, overlap at the edges, and give trouble, especially if the stuff has not been thoroughly well seasoned. If lagging strips are wide and thick the same evils will happen. It is a pity to spoil a pattern by saving a little time in jointing up and gluing. Patterns well made will endure in frequent use for many years, but those clumsily made will be falling to pieces in a few weeks or months.—English Mechanic and World of Science.

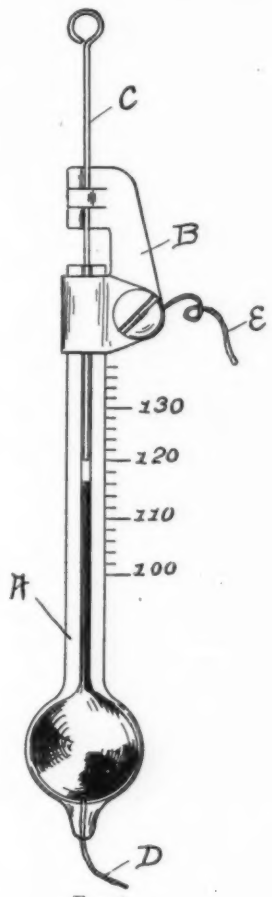


FIG. 1.

FERTILIZERS AND ELECTRIC PROCESSES.

THE question of the different chemical products which are to be used as fertilizers is treated by Th. Schlösing, with special reference to the new processes for the manufacture of nitrates in the electric furnace. As to the kind of nitrate which is used generally at the present time for fertilizer, we find that nitrate of soda seems to be in the most common use. However, it is not to be doubted that nitrate of lime may be considered as an equivalent, provided we use the same amount of nitrogen, at least we may say that nitrate of lime ranks as a fertilizer of the first class, for the nitrogen, after the natural process of nutrification which takes place in the soils of different kinds, no doubt is presented to the roots of the plants in the form of nitrate of lime and is thus taken up by the roots. In spite of the great probability that this condition of affairs holds good, it is not without interest to verify this equivalence by experiment, especially seeing that nitrate of lime is now being produced commercially by new processes. The production of nitric acid from the elements of the air by means of the electric furnace which is now carried on in Norway, for instance, by the method of Birkeland and Eyde, will no doubt have considerable influence upon this branch of the chemical industry, and besides is likely to be of great interest in agriculture. In fact the new process will be able to furnish considerable quantities of nitrate of lime which will be added to the nitrates of soda from Chile and will be able to replace the latter when the supply becomes exhausted. The writer describes the experiments which he made upon a number of samples of nitrate of lime manufactured by the electric furnace process. It contains 13 per cent of nitrogen. The tests were made at the same time upon nitrites. The above process gives a part of the nitrogen oxidized in the state of nitrite of lime, which it transforms into nitrate, seeing that the nitrites are not used at present as fertilizers. But it is a question whether we should proscribe the nitrites, and the present tests were made to show what value it may have as a fertilizer. The test was carried on with yellow corn planted in pots (July to October, 1905) and in each lot we find 9 kilogrammes of Boulogne earth and 0.405 gramme P_2O_5 (superphosphate) plus 1,500 grammes sulphate of potash. The nitrates and nitrites were added at the rate of 0.200 gramme nitrogen for 9 kilogrammes of earth or about 80 kilos per hectare. Four different conditions of soil were used. First, soil without addition of nitrogen. Second, using nitrite of soda and nitrite of lime. Third, with nitrate of soda. Fourth, nitrate of lime from Norway. The weight of the dry product of the plants was found in the following order for the above cases, in grammes: 43.3, 54.6, 54.2, and 54.0. The tests therefore seem to show that with the same proportion of nitrogen, the nitrates and nitrites which were employed here showed themselves to be of equal value. The experiments are to be carried on in the same direction on a larger scale to see whether this always holds good.

AN ELECTRO-THERMOSTAT.

By EDWARD F. CHANDLER.

IN the SCIENTIFIC AMERICAN SUPPLEMENT, No. 1561, appears an article entitled a "Thermostat for Amateurs." This little device will prove very effective where gas is used for heating, as a practically constant temperature may be maintained by exerting a little care in the adjustment of the instrument.

When it is necessary to use liquid fuel in place of gas, we would find our "gas regulator" quite useless. Therefore it would be necessary to construct a piece of apparatus to meet these new conditions, and the instrument shown in Fig. 1 will prove of value, especially as its construction permits of its being used in a great many ways. It may be employed, for example, as an automatic circuit closer, actuated when the mercury in the tube reaches a previously set point, so that a contact is made and the circuit of the alarm-sounding apparatus completed. (Fig. 2.) In place of a bell an arrangement could be made so that the size of the lamp flame would be affected by the closing of the circuit, thereby raising or lowering its heating qualities.

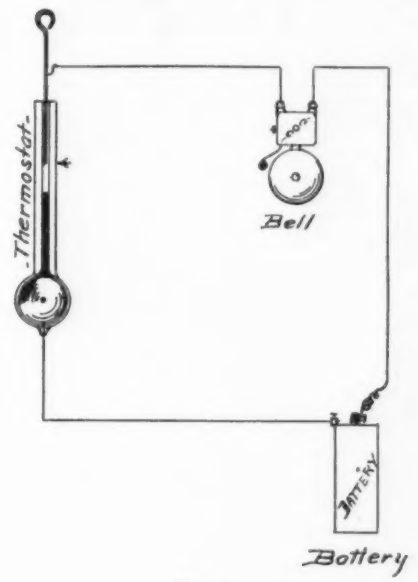


FIG. 2.

In this article, nevertheless, I will confine my description to the alarm system, as it is much simpler and more easily made.

Referring again to Fig. 1, we note that the tube *A* very much resembles a thermometer tube, except that the top end is open and that an iron wire, *D*, is fused into the lower part of the bulb. The making of the tube is quite simple, the iron wire being inserted while the glass tube is still hot. The glass is melted down with a blowpipe so as to make an air-tight connection. The next step is the blowing of the bulb, and so on through the mercury-filling operation, exactly as in the making of a thermometer, until at last, instead of sealing the small end it is left open, having been cut off a little above the mercury column at its highest level.

The arm *B*, which holds by friction the iron wire *C*, is made from thin sheet brass and wrapped about the glass tube as shown, being held by a screw and nut, which also serve as a binding post for the wire *E*.

Fig. 1 shows the instrument set for 120 deg. The

wires *C* and *D* must be of iron, so as to withstand the corrosive action of the mercury. This regulator is particularly commendable for use in connection with drying ovens, incubators, and similar apparatus where an excess in heat would be a serious matter. The electro-thermostat may also be used in combination with the gas regulator for the purpose of affording a second index in more delicate operations.

As commercial mercury often contains adulterations which tend to lessen its mobility, it is well to wash it with dilute nitric acid, in order to dissolve out some of the more readily soluble foreign metals. Fairly pure mercury should not leave a streak upon the surface of a dry porcelain dish; thus condition may be brought about, if the mercury is not too impure, by straining through chamois skin. These precautions are taken in order to render the instrument as sensitive as possible to the least change of temperature.

DIAMOND IMPORTATIONS.

More than 36 million dollars' worth of diamonds and other precious stones have been imported into the United States during the present calendar year. This importation of diamonds and precious stones is by far the largest in the history of the United States, the high-water mark in earlier years having been 28½ millions in 1903, while 1904 showed but 27¾ millions. In the ten months of 1905 ending with the month of October the total is over 31 million dollars, or more than in any full year prior to 1905. This importation of the ten months, amounting to $31,359,157, gives an average of over 3 million dollars per month, so that it may reasonably be assumed that the figures for the two remaining months will bring the total up to 36 million dollars, as against 27¾ million dollars in 1904, and 28½ millions in 1903.

It was not until the year 1901 that imports of diamonds and other precious stones ever passed the 20-million-dollar mark. In the period from 1888 to 1892 the importations of diamonds and other precious stones averaged about 12 million dollars per annum. With the depression which followed, however, the importation dropped to about 7½ million dollars in 1894 and a little less than 5 millions in 1896, and to about 6½ millions in 1897, but began to increase in 1898, when it reached nearly 10 millions, and was by 1899 16½ million dollars in value, in 1901 more than 23 millions, in 1903 28½ millions, in 1904 27¾ millions, and in 1905, as already indicated, seems likely to be fully 36 millions.

This group, "diamonds and other precious stones," which will aggregate 36 million dollars in the imports of the year, is composed chiefly of diamonds, the "other precious stones" forming but about one-fifth of the total value of the group, and diamonds forming about four-fifths. It is probable that the value of diamonds alone brought into this country during the present year will be nearly or quite 30 million dollars and the "other precious stones" approximately 7 million dollars. The diamond importations of the present year will be about three times as much as those of 1890 and nearly six times as much as the average during the period 1894-1897.

One interesting feature of the record of diamond importations, shown by the Department of Commerce and Labor through its Bureau of Statistics, is the rapid growth which has occurred in that group of diamonds classified as "diamonds, uncut." An attempt was made a few years ago to establish a diamond-cutting industry in the United States, and this has apparently been extremely successful, since the value of uncut diamonds imported has greatly increased during the last decade. In 1896, the value of uncut diamonds imported into the United States was $78,815, in 1897 practically 1½ million dollars, in 1898 about 2½ millions, in 1899 over 4½ millions, in 1901 about 6½ millions, in 1902 over 8 millions, in 1903 over 10 millions, and in 1905 will also exceed 10 millions.

The growth in the diamond-cutting industry in the United States is evinced not only by the increase in the importation of uncut diamonds but also by the census figures, showing that the number of persons engaged in "lapidary work" increased from 92 in 1896 to 498 in 1900, and the value of the material used increased from $124,852 in 1890 to $4,655,765 in 1900, and the value of products grew from $315,604 in 1890 to $5,786,281 in 1900. The value of uncut diamonds imported in the decade ending with 1905 will aggregate about 60 million dollars and of cut diamonds about 100 million dollars, while the value of other precious stones imported in the same period amounts to considerably more than 36 million dollars, making the grand total for the decade for diamonds and other precious stones approximately 200 million dollars.

Most of the diamonds entering the United States, while they originate in distant parts of the world, chiefly South Africa, reach the United States from European countries—the United Kingdom, Netherlands, France, and Germany. The United Kingdom, in whose South African possessions the greatest diamond mines of the world are located, has sent during ten months ending with October 8½ million dollars' worth of diamonds, of which about 5 millions were uncut and over 3 millions cut but not set. The Netherlands also sent 8 million dollars' worth, of which 1 million dollars' worth was uncut and 7 million dollars' worth cut but not set. France sent about 3 million dollars' worth, of which less than one-half million dollars' worth were uncut and over 2½ million dollars' worth cut but not set. London, Amsterdam, and Paris are the great diamond-distributing centers of Europe, drawing their supplies chiefly from South Africa, but the marked difference in these three centers of distribution is that Amsterdam and Paris have large diamond-cutting industries and the diamonds which they distribute are generally cut, while, as above indicated, a large proportion of those supplied to the United States from Great Britain are uncut.

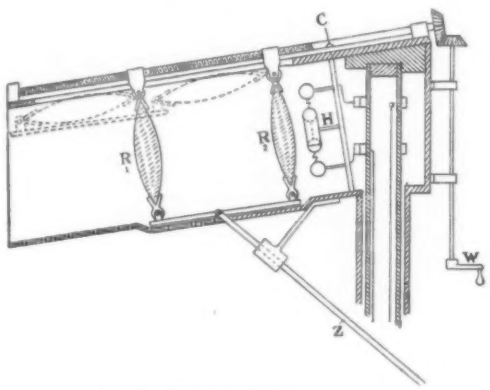
The United States is the largest diamond-importing country in the world, especially when the imports for domestic consumption—or, in other words, for permanent ownership by her people—are considered. Certain of the European countries, notably Netherlands, Great Britain, and France, import large quantities of diamonds, but these are for re-exportation, Great Britain taking the bulk of those produced in her South African colonies, where the principal diamond mines of the world are located, but re-exporting a large proportion of them, while Netherlands and France, which also import large quantities of uncut diamonds, have important diamond-cutting industries and re-export large quantities of the cut stones ready for mounting.

A writer in the Encyclopedia Americana, issued in 1903, states that one-third of the entire amount of cut stones of the world are owned in the United States, and another writer in the same volume, Mr. George F. Kunz, estimates the value of all the diamonds known to exist in the world to-day at 1 billion dollars and adds that about 500 million dollars' worth are owned in the United States and that "therefore it may safely be said that one-half of all the diamonds known are owned in the United States."

THE TELEMOBILOSCOPE.

CONSUL BARDEL, of Bamberg, Germany, reports the invention of the telemobiloskop by a resident of Düsseldorf, an apparatus which merits the attention of all seafarers, and which is said to have gained the special attention of German maritime circles. Describing the telemobiloscope, Consul Bardel writes:

"The telemobiloscope is to enable the pilot of a ship, in foggy weather, to discover the nearness of another vessel, even if the pilot of the other vessel neglects to give signals by which he could make himself heard. The apparatus works automatically, so that after it is once adjusted nothing whatever has to be done until a ship is discovered by it, when, by an unimportant manual action, the nearness of the other ship can be disclosed. The invention is based on the principle that electric waves, such as are used by wireless telegraphy, are reflected the moment they strike metallic objects in their course, while otherwise they continue on their journey.



THE TELEMOBILOSCOPE.

"The accompanying sketch shows a part of the apparatus. The carrier of the same is the axle, *C*, which has to be hung so that with all the motions of the ship it has to remain in the same vertical position. Around this axle, moved by a machine, turns the large projecting box, which slants off somewhat toward the water, and, standing on some high elevation, perhaps the mast, continually searches the ocean for another vessel. *H* represents the inductorium of the sparks. Here, as the little darts indicate on the sketch, sparks generate continuously, which sparks form the electric waves which are sent out of the projecting box to the surface of the ocean. The inventor claims that every large ship can produce electricity, and with the modern steamers and men-of-war it is only a question of tapping a small quantity of it from existing plants to properly feed *H*.

"In order to make the electric waves travel compactly in a body, two lenses, *R*, are adjusted inside the box; they are to shape the electrical waves into a cylindrical bundle. This mass of waves, now in constant rotation, with a slanting tendency toward the horizon, searches the surroundings. If the waves strike a ship (all ships have metal parts of some kind), a reflex will bring them back to where they started. To catch this a receiver, similar to those used for wireless telegraphy, is adjusted over the projecting box. A metal plate between the receiver and the box so separates the electrical waves that only those returning can strike the receiver. The receiver at once indicates to the captain that a ship is near, and locates her. To discover the exact distance to the other vessel, the lenses *R* are so turned, by means of the handles *W* or *Z*, as to get the strongest reflection from its metal parts, which the loudness of the indicator will mark out."

A concession has been granted to a Swiss company for the construction and working of an electric railway in Switzerland between Sépey and Ormont-Dessus.

CONTEMPORARY ELECTRICAL SCIENCE.*

PROPERTIES OF SPACE AT HIGH POTENTIAL.—A. M. Worthington has performed what he calls "a fundamental experiment in electricity," by sending two beams of light through two parallel tubes charged to different potentials, and noticing, by means of an interferometer, whether there was any difference in the rate of propagation of the two beams. The results were negative. No difference in the velocity of light in the high-potential and the low-potential space could be detected. This experiment is supplemental to that of Faraday, who detected no action on electrified matter inside a conductor due to a charge on its surface.—A. M. Worthington, Philosophical Magazine, September, 1905.

VERTICAL-INTENSITY VARIOMETER.—A. Von Büky claims to have devised an instrument for measuring the variations of the earth's vertical magnetic field more accurately than heretofore. The instrument consists essentially of an astatic combination of needles hung in a bifilar suspension at right angles to the magnetic meridian. A bundle of thin rods of soft iron is placed in a vertical position broadside-on to the needles some distance away. The horizontal intensity has no effect upon the astatic combination nor upon the vertical iron rods. But the earth's vertical field induces a north-seeking pole in the lower end of the soft iron and a south-seeking pole in the upper end. These poles exert upon the needles near them magnetic moments in the same sense, and these moments are proportional to the vertical intensity. The author uses a special device for correcting for temperature, in the shape of an auxiliary magnet mounted on the side opposite the soft iron and pointing toward it. It is turned in such a manner that its effect is opposed to that of the soft iron, and its distance is determined by calculation in such a manner that its change of moment balances the changes of moment of the other magnetic bodies. The nearer the compensating magnet is to the suspension the less sensitive is the variometer. —A. Von Büky, Physikalische Zeitschrift, September 1, 1905.

INFLUENCE MACHINE PHENOMENA.—J. R. Januszkievicz describes some hitherto unknown phenomena observed with a Voss single-plate influence machine. A light metallic body is suspended by a cocoon fiber and brought between the spherical electrodes of the machine while they are beyond the maximum discharging distance apart. In most positions, the metallic body is pushed violently to and fro, but a position of greater stability may be found in which the body approaches the negative pole, while the thread is bent down and round in the shape of an inverted note of interrogation. Another experiment shows the extraordinary sensitiveness of the positive-brush discharge. The two terminals are 5 centimeters in diameter, and 20 centimeters apart. The positive terminal has a point directed toward the negative terminal, and from this point a brush discharge issues. A fine point is now gradually made to project from the negative terminal. The brush discharge is extinguished when this point projects only 0.05 millimeter. When an earthed piece of wire netting is placed midway between the spheres, the point may be protruded 0.07 millimeter before it again extinguishes the brush. Two wire nets allow of a distance of 0.08 millimeter, but when the two nets are several millimeters apart, the effect of the point on the positive-brush discharge is entirely nullified.—J. R. Januszkievicz, Physikalische Zeitschrift, September 1, 1905.

NITROGEN ATOMS AS CURRENT-CARRIERS.—Following up his work on the continual evolution of hydrogen atoms from the cathode, and its quantitative transfer in accordance with Faraday's law of electrolysis, C. A. Skinner proves that in the case of carbon electrodes nitrogen plays a similar part. Three carbon disks (15 millimeters in diameter) cut from hard arc carbon were mounted in the electrode tube, and this was evacuated and left over night connected with a drying chamber. The next day the slight amount of gas which had been given off was pumped out and helium admitted to a pressure of about 3½ millimeters. With an aluminium disk serving as anode and one of the carbon disks as cathode, a current of 2 milliamperes was passed through the helium. A spectroscopic observation of the cathode revealed a gradually-brightening nitrogen radiation, in addition to that of helium. Measurements of the nitrogen evolved and of the current passed proved that the nitrogen was in accordance with Faraday's law. On substituting a carbon disk for the aluminium anode, it was found that for seven minutes the absorption of nitrogen by the anode also follows Faraday's law. The author gives explanations of the electrode fall, of photo-electric currents, and of contact potential based upon the following considerations. With a gas filling which is chemically neutral and is not absorbed by the substance composing the electrodes, the electric current between cathode and gas filling is carried by negatively-charged atoms of gas which are already to be found in solution of the cathode. These negative atoms give up their charge to the gas filling by neutralizing positive ions of the gas filling. If the cathode possesses a sufficient supply of absorbed gas this neutralization takes place outside the cathode, indicated by the fact that the gas pressure increases at a rate demanded by Faraday's law. If, however, the absorbed gas falls below a definite concentration it does not go out of the cathode at a rate sufficient to carry the whole current, but this is probably made up by the positive ions of the gas filling penetrating the cathode and discharging to the ab-

* Compiled by E. E. Fournier d'Albe in the Electrician.

sorbed gas inside just as in the other case they discharge to it outside the cathode. If these penetrating ions be chemically and physically neutral they will diffuse back uncharged into the gas filling. This view explains the fact that evolution of gas from the cathode falls after a time below Faraday's law.—C. A. Skinner, Physical Review, September, 1905.

ENGINEERING NOTES.

It is difficult to form any estimate of the amount of damage inflicted by soft coal smoke in a city like Pittsburg or Cleveland, but it probably amounts to hundreds of thousands of dollars annually. The deterioration of dry-goods, draperies and delicate fabrics on the shelves and counters and in the show-windows is a direct tax on the buyer. In the book trade the situation is perhaps worse. Our libraries, public and private, are suffering day by day, and our art collections grow more and more dingy. Cleveland can produce an old master "while you wait."

In his presidential address to the Junior Institution of Engineers, Mr. Dugald Clerk dealt with the important problem of the gas turbine, and expressed a somewhat pessimistic view as to its solution. With this expression of opinion we are very much inclined to agree. Mr. Clerk pointed out that, even assuming an efficiency of 90 per cent in the compressor, 90 per cent in the nozzles, and 80 per cent in the turbine, the apparatus would probably still fail to compete successfully with the ordinary reciprocating gas-engine. It is, of course, extremely unlikely that an efficiency of 90 per cent will be obtained with a rotary compressor, which alone seems suitable for this work. Mr. Clerk declares that he has never heard of one compressing to 9 to 10 atmospheres which had an efficiency of anything like 60 per cent; but we are inclined to think that, taking a line through the steam-turbine, an efficiency not very far off this latter figure might be realizable with careful design. The over-all internal efficiency of the Elberfeld turbine at full load was fully 70 per cent, corresponding to a stage efficiency of about 66 per cent. There seems no reason why a similar stage efficiency should not be reached in a compound compressor, in which case the over-all internal efficiency would not be far off 62 per cent, and a total efficiency of fully 60 per cent would therefore seem practicable.

Heating of feed water may be accomplished in two or three ways: First, by means of the exhaust steam, which, coming from a non-condensing engine, is capable of heating the feed water to 212 deg., and of saving say, 12 to 15 per cent as compared with feeding cold water. For large plants where it would pay to use induced draft to make up for the loss in temperature of the chimney gases which produce the draft, it will undoubtedly pay to use an economizer, but as this apparatus is expensive both in first cost and upkeep, the amount saved in utilizing the waste gases from a small plant would probably not offset the outlay. The closed type of feed-water heater is about as efficient as the open type, provided the water is pure, and it avoids trouble from pumping hot water, but the open type is frequently made use of to assist in purifying the water and if properly managed may give good service in that respect. For condensing engines, a primary heater of the closed type may be installed between the engine and condenser, which will help to condense the steam and heat the feed water to a low temperature, say, 130 deg. to 140 deg. F. A secondary heater, either of the closed or open type, may be used to heat the feed water to a still higher temperature, say, 212 deg., by the use of the exhaust from the feed and air pumps, which cannot be used more profitably than in this way, as all the heat is returned to the boiler.

At the taking of the census in 1850 twenty-three castor-oil mills were reported for the entire United States; of these, ten were in the State of Illinois; three in each of the States of Missouri and Virginia; two each in Ohio and Tennessee; and one each in Pennsylvania, Alabama, and Arkansas. All were small establishments, doubtless of crude equipment, and evidently designed only for manufacturing the small crops of near-by farms, excepting that in Missouri St. Louis had already become, as it has since remained, the principal commercial center of castor-oil production in the West. As measured by the value of the oil produced, upward of 70 per cent of the total production of castor oil in the United States at that date was made in the Missouri mills. Though no statistics were taken of the actual production of castor beans, it is evident that the bulk of the entire crop was raised in territory tributary to St. Louis; in other words, as early as 1850 the cultivation of castor beans was already largely specialized in that section, beyond which it has never extended on an important and enduring scale. In the Eastern States the castor plant, on account of its ready susceptibility to injury from frost, and other causes, has never been cultivated for industrial purposes. But, on account of the important consumptive market there for castor oil and the facilities for importing castor beans, attention was early attracted to the industry on the Atlantic coast. In 1857 a mill was erected in Jersey City, N. J. This was the largest mill, equipped with the latest improvements in machinery and constructed exclusively for the manufacture of castor oil, that had been erected in the United States. The industry thus became largely centralized in Jersey City and St. Louis, cities which have since remained the leading markets for castor beans. The respective advantages of each location with reference to the two sources of supply, domestic and foreign, are obvious. Many small mills, about this time, went out of business, and at the taking of the census in 1860 only eight castor-oil mills were reported for the entire country against 23 in 1850. Of the capital invested in these, half was represented by the two mills in Jersey City and St. Louis.

ELECTRICAL NOTES.

A new electrical device for indicating the stations is now in use on one branch of the Berlin city tramways, the Mittelstrasse-Pankow section, and it is said to give good results. The device has been brought out by a Danish inventor, M. Jens Chr. Schmidt. It consists of a small glass-faced wood case which is placed inside the car above the door where the name of the station can be seen by all the passengers. In the box are two drums over which rolls the paper having the names of the stations printed on it. A clockwork motor operates the drums and it is controlled by an electro-magnet which stops it and then releases it, working by a ratchet wheel. The current comes from the overhead wire. At certain points on the wire is attached a kind of annex wire or bar and against the bar strikes a tongue or extra wire which is carried upon the trolley pole. The arrangement varies with the kind of trolley which is used. Thus a current impulse is sent along a special wire into the electro-magnet at the right time causing the clockwork to unroll the cylinders until the next point of the ratchet and bring the name of the next station to the proper place behind the glass. At the same time the clockwork rings a bell so as to warn the passengers. Should the apparatus fail to work, the conductor can operate it by hand.

Some new indications as to the performance of tantalum lamps are given by M. Zengler, one of the engineers of the Siemens & Halske firm. He states that the results of recent tests made upon such lamps show that when they are supplied with alternating current their performance is not as good as in the case of direct current. The lamps appear to last a considerably shorter time and besides the bulb is found to blacken more than usual. Regarding the life of the lamps when running on direct current, the author gives a total life of 1,000 hours as a minimum figure. The life when taken down to the lowest useful candle-power is from 500 to 600 hours. It is to be remarked, however, that Prof. Wedding found a higher figure than this as a result of his tests. M. Zengler states that the Siemens & Halske firm are producing a new tantalum lamp which is run somewhat lower than the normal lamp and consumes about 2.2 watts per candle-power. The life of these lamps is twice as long as for the normal lamp, and they are made at a lower candle-power.

From the standpoint of refractory materials the electric furnace represents a distinct gain. The temperature at which ordinary crucible or muffle furnaces can be operated is limited by the resistance which available refractory materials offer to melting, and to the corrosive and fluxing action of materials to which it must be exposed. The same refractory materials may be used for higher electric furnace temperatures since the materials to be heated, as well as the source of heat, is within the refractory walls. Where the heat has to be transmitted through such walls in other forms of furnaces the material to receive the heat cannot receive so high a temperature. Further than this, the refractory walls of the electric furnace can be kept cool by artificial means, such as an air blast or water circulation, and a still more advantageous property is that the material undergoing treatment may itself constitute the walls of the furnace. This advantage of interior heating is utilized in the production of phosphorus and carbon bisulphide, most of which is now produced in the electric furnace, the greater cost of electrical heating being more than compensated by the saving in crucibles and retorts, the destruction of which constituted large items under the older methods.

One of the most important of the applications of telegraphy is that of directing and controlling the movements of trains on railways. For this purpose a modification of the old semaphore telegraph was introduced in the early railway days, mainly for the protection of traffic at stations and crossings. By this means the range of the signals was extended so as to cover the whole length of a section, and this led to the practical introduction of the block system of working traffic. Lately, definite advances have been made in two directions in this field of applied electricity. In the first, complete electrical systems of actuating points and signals have been introduced, the apparatus providing interlocking gear and indicators, which give the signalman positive information as to the position of every point and signal; the working being easy, rapid, and apparently reliable in so far that every eventuality and cause of trouble appears to have been foreseen and provided against. This method admits of working points and signals at distances far in excess of the manual system; such distances, in fact, only being limited by considerations of safety and convenience, and the heavy and cumbersome lines of levers that under old methods could, in many cases, only be worked by the full exertion of the signalman's strength, can now be replaced by miniature levers, which only need intelligence to work them. In another direction automatic methods have been designed for working outdoor signals directly by the action of the train itself, its entry, continuance in, and exit from, a section being faithfully followed by the appropriate movements of the semaphores. Automatic signals appear to meet a definite want on certain classes of railway, although no doubt the day is far distant when the trained signalman will be dispensed with at complicated junctions and stations.

SCIENCE NOTES.

A survey of recent work in tropical medicine shows us that investigation is chiefly being directed to the study of protozoal diseases. No advances of fundamental importance have been made with regard to malaria since the classical investigations were published with which the names of Ross and Manson, Grassi, Bignami and Bastianelli will ever remain associated. The earlier work has been confirmed and extended by many investigators. The prevention of malaria by means of mosquito destruction and other measures directed against mosquitoes has been tried in various localities, in some instances with success, in others with doubtful results. This is, however, only what might be expected in view of the diversified difficulties which must necessarily arise.

It is true that we now have general maps of the larger parts of the world, which more or less convey a fair representation of the configuration of land and sea when large areas are considered, but details are sadly lacking almost everywhere. To many people one map is as good as another. They do not pause to consider on what it is based or what degree of accuracy it probably possesses, but so long as there is a map they are satisfied. A vast number of existing maps are compiled from the roughest materials; in partly occupied countries, from drawings of small areas placed together as can best be done, by means of places here and there, the relative positions of which are fairly known by distances along roads, with perhaps in some cases angles and astronomical positions; in less civilized parts by routes of travelers laid down by estimation of the distance traversed and direction of march, checked perhaps by a few astronomical observations of more or less value as the traveler possesses or does not possess the necessary skill.

The economic relations of bacteria and fungi must be studied with special reference to controlling and protecting the valuable species and guarding against the injurious species. The farmer should be able to recognize the more important and destructive plant diseases and know how to guard against them. He must understand the principles of reproduction and propagation and methods of plant improvement by seed selection, cultivation, and hybridization. He must know how to maintain and increase the fertility of soils and must recognize the adaptability of soils to special crops. This involves a knowledge of food requirements of special crops and the most economical means of furnishing the required food. In a host of other ways also, a knowledge of the physiology of plants will enter into the technical processes of farming or fruit growing. The paramount idea should be not to make botanists, chemists, or zoologists, but to furnish the foundation training for the development of experts in farming, or fruit growing, or animal husbandry. There must be the closest sympathy and touch between the investigator, the teacher, and the practical worker. They are a trinity with a unity of purpose—the development of a perfect art of agriculture.

M. Loewy, the director of the Paris Observatory, has lately presented to the Académie des Sciences the first volume of the photographic Catalogue of the Heavens, which contains the rectilinear co-ordinates of 49,772 stars relative to the zone included between + 16 and + 18 degrees of declination. This region had been allotted to the Bordeaux Observatory for exploration, and the new volume is published by that observatory, under the direction of M. Rayet, the chief astronomer. Several publications of the same kind relating to other regions of the heavens and coming from the observatories of Algiers, Paris, and Toulouse had already been presented to the Academy. Thus it is seen that the four prominent French establishments which promised their co-operation in the vast enterprise of the photographic Map of the Heavens have faithfully kept the engagements which they contracted and are working together with success toward accomplishing a work which will be an honor to our century. In the same way as for different other branches of science, there is often in astronomy a valuable criterion for judging at once as to the intrinsic value of an observation, and that is where the astronomer has furnished a detailed account of all the means he used in the work. Thus we are able to follow by degrees the different stages of the process and to judge the value of the precautions which are taken to secure exact results. This examination becomes especially convincing when the author himself, by special experiments, brings out the degree of precision obtained in the different partial observations upon which the definite results depend. M. Rayet has done this in the present work. He evaluates successively the degree of the accidental errors of the measurements made either upon the lines of the ruled screen or upon the images of the stars. A complete research has been made besides for finding the influence of the form of the star images upon the measures, as the form is often variable. The images are circular or more or less elliptic and the axes of the ellipses have often very different directions in the various regions of the photographic plate. M. Rayet makes a study of the influence of the accidental error coming from this source in the measurements of each observer. He also indicates the relation which appears between the photographic size of the stars and the respective value of the accidental error of measurement. The errors in the divisions of the standard gratings and the curvature of the lines have also been made the object of an approximate research. Thus we are in a position to see *à priori* that the star co-ordinates which are given here possess the degree of exactness which we might expect. The work also contains an interesting research made

by M. Kromm as to the determination of the positions of the stars in the group of the Pleiades. The same astronomer had charge of making the calculations and the formation of the star-catalogue, while M. Courty directed the photographic exploration of the heavens. The Bordeaux Observatory has therefore well carried out its share in the contribution toward the photographic map of the heavens.

TRADE NOTES AND FORMULÆ.

Luster Paste.—(For plate glass, picture frames, and metal.) 5 kilogrammes of very finely washed and pulverized chalk, 5 kilogrammes of Vienna lime powdered, 5 kilogrammes of bolus powdered, 5 kilogrammes of wood ashes powdered, 5 kilogrammes of English red powdered, 5 kilogrammes of soap powder. Work all together in a kneading machine, to make a smooth even paste, adding spirit. The consistency of the paste can be varied, by varying the amount of spirit, from a solid to a soft mass.—Der Chemisch-Technische Fabrikant.

Black Shoe Dressing Without Turpentine.—2 kilogrammes of paraffine, of high melting point, 1 kilogramme of wool grease, crude, 0.5 kilogramme of soda lye, 38 deg. Bé., 2 kilogrammes of Carnauba wax, 0.5 kilogramme of nigrosine, fat-soluble, 25 kilogrammes of water, 0.4 kilogramme of nigrosine, A. R., water-soluble. Heat paraffine and wool grease to 100 deg. C., add the soda lye gradually and boil 20 minutes, until the mass is of uniform consistency. Add the Carnauba wax gradually, boil until it is thoroughly assimilated, then dissolve the nigrosine in the mass, and add 15 kilogrammes of hot water, a little at a time, stirring constantly. When the mixture has become a cream of uniform consistency, stir in the water-soluble nigrosine, dissolved in the remaining 10 kilogrammes of hot water and 50 grammes of formaline.—Der Chemisch-Technische Fabrikant.

Leather Cement.—40 kilogrammes of aluminium acetate, 10 deg. Bé., 10 kilogrammes of glue, 10 kilogrammes of rye flour. These materials are either to be simultaneously mixed, and boiled, or else the glue is to be dissolved in the aluminium acetate, and the flour stirred into the solution. This is an excellent cement for leather, and is used in the so-called art work with leather, and with leather articles which are made of several pieces. It is to be applied warm, and can be put up for the market either in a gelatinous state, or in solid form, dried like gluten, in thin strata on oiled plates. For use it is dissolved in hot water, and has advantages over both glue and gluten. A special point is that it is pliant, while these are brittle. In joining pieces of leather and other flexible materials, it will not break or lose its binding power, while glue and gluten, being brittle, can only be used for stiff substances. It has the further advantage of not fermenting or putrefying, as is the case with gluten, and therefore has none of the injurious miasmatic effects that this does. Lastly, leather dressed with oil can be glued with this cement, a thing which can be only imperfectly done with the much more expensive gluten.—Der Chemisch-Technische Fabrikant.

Improvement in Dyeing with Turkey-Red.—Dyeing in turkey-red ranks in dyeing technique as a specialty; partly, no doubt, because of the beauty and permanence of the shades, and also because of the comparative complexity of the operations. The process, chemically, is of great interest. The mechanism of the operation has been made clear as a whole, but there remains some uncertainty in regard to the compounds which, with alumina, lime, and alizarine, form the quaternary lake, which characterizes this coloring matter. The exact nature of the fatty acids, of great molecular weight, the modifications they undergo at temperatures from 115 deg. to 120 deg. C. (239 deg. to 248 deg. F.) during the brightening, that is to say, during the actual formation of the turkey-red lake, are still ill defined. Alumina, too, is found in various forms in diverse molecular states. What is best? This is still a question which chemistry has not examined thoroughly, and of which the solution is left to the tentative efforts of the operator.

It is known that lime plays an important part, in spite of the small proportion of this oxide, in the final lake. The presence of lime, even much diluted, as in lime water, is an indispensable condition for the development of turkey-red.

Although, during the last ten years, eminent technicians, such as Koechlin and Starck, have shown how the operations and time necessary can be limited, it has not yet been possible to obtain permanent results by the appliances of modern machinery.

To secure the prime conditions required in a dye, clear solutions are needful, and it has been impossible to dissolve alizarine in such a way as to utilize it in the manufacture of a veritable solid turkey-red.

But the problem appears to have now been solved by F. Kornfeld, who has found in the saccharate of calcium the proper solvent for alizarine. This salt is sufficiently alkaline to keep the color in liquid solution, and it contains the lime necessary for the formation of the lake, and in such a form as to displace the alizarine only when a third body intervenes, a caustic such as aluminium, for instance, fixed on the textile fiber. To obtain the machine red, the preliminary mordants, the preparation of the tissues, must be produced by forms of alumina and fatty acids that cannot cause the premature precipitation of the mordants or the coloring matter in the baths.

These difficulties have been overcome by this process. Dyeing with turkey-red by machinery has been tested on a large scale.—Translated from the Chemische Zeitung.

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